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TROUT CULTURE.

C. C. CAPEL.

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TROUT CULTURE.

A PRACTICAL TREATISE

ON THE ART OF

SPAWNING, HATCHING, & REARING TROUT.

BY

CHARLES C. CAPEL, F.R.M.S.

SECOND EDITION.

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PREFACE TO SECOND EDITION.

SINCE the first issue of this little work in 1877, there have been held three great Exhibitions—Berlin, Norwich, and last, the Great Show in London in 1883. The world has, doubtless, reaped a vast amount of practical information from these displays, but it is a nice question whether the Fisheries of the world have, in reality, reaped any great benefit.

Anyhow, the lines of Fish Culture, so far as the writer can see, remain very much in the old groove; perhaps from want of observation, or other causes, he failed to extract much information from the great "Fisheries" of 1883.

With this brief introductory Preface, the author begs to offer to the Press, and, he hopes, an indulgent public, a fresh issue of his little book on Trout Breeding.

CRAY FISHERY,
FOOT'S CRAY, KENT.

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INTRODUCTION.

IN bringing out this little work on the Culture of Trout, the author feels that he is attempting to supply a great want, as many landed proprietors, desirous of stocking their waters with that fish, naturally wish for some simple practical work wherein they may find information which will serve for a help to the servant as well as to the master, especially in the absence of the latter.

The author, in his first attempt at Pisciculture, would have been truly thankful for such a guide; and, with the hope that they may be of use to others, and enable them to enter upon a successful career, he now ventures to publish the results of his own practical experience.

His grateful acknowledgments are due to the Rev. L. Stone for the account of the Russian or Dry method of Spawning, and for the Spawn and Hatching Tables, &c.

All the methods of procedure recommended have been personally tried, and nothing has been taken from the works of others, so far as the author is aware, without due acknowledgment.

CRAY FISHERY,
FOOT'S CRAY, KENT.

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TROUT CULTURE.

CHAPTER I.

PRELIMINARY CONSIDERATIONS.

THE three qualities most needed in order to become a successful trout-rearer, are Patience, Endurance, and Ingenuity. Without these no enterprise can well succeed, and pisciculture is assuredly no exception. In fish breeding patience is required, because its duties are what some might call monotonous: the round of work is regular, and must be carried on much the same, day after day, month after month, with, it may be, very slight variation; but still, the work soon grows into a habit, and when once a system has been formed the tiresomeness of daily duties is much lessened; and from daily association a sort of attachment spontaneously grows up between the attendant and his charges, which does much to dispel the monotony of the work.

Endurance, again, is needed, as the spawning and hatching of trout take place in winter, and the coldness of the water is very trying to the hands and arms; this, however, is but a small matter if the rest of the

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body be protected by good woollen clothing and the feet encased in waterproof boots. The subject of clothing will receive more attention at the end of this chapter.

Ingenuity, again, is essential, because accidents and misfortunes will happen even to the experienced, and then, he who is the most ready to devise a remedy, or means of escape, will find his quickness of resource amply repaid, and of the greatest value: as if anything happens to young trout, unless speedily set right, it usually affects the whole of that stock. He, therefore, that would successfully rear trout must make up his mind to be constant to duty, fearless of difficulty and obstacle, and quick to act, ready to face cold, snow, and ice; he must be prepared also to buy experience at some cost; and it is the object of this little work to reduce that cost as much as possible.

We have put before the reader the unpleasant part of the picture; now, let us turn to the sunny side. What can be more enjoyable than a fine winter's morning, such as we often have in January, with the sunshine dancing among the ripples of the little streams as they rattle over the golden gravel?

"Saw some fine fish up spawning in the Alders this morning, sir. Six or eight there, and lots in the stream above the farm." Cheering news, this, as we meet our faithful lieutenant outside the hatching-house, bustling about amongst nets, tins, &c. How one gloats over the prospect of a good day's spawning! What a lot of intelligence the wily fishes evince, too, in doubling and baffling their pursuers! Personally, we would rather have a good day at this than at angling.

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Again, what a charm there is in a well-ordered hatching-house, with its millions of golden eggs covered with bloom like a ripe peach! Fish culture is indeed a charming amusement, free from cruelty, and full of enjoyment for anyone who has a love for Nature and her beauties.

Some one may, doubtless, think that the colouring of this picture has been laid on with a too generous hand: let him try for himself, and it is almost certain he will admit that there has been no exaggeration.

Before this chapter closes, a few remarks on clothing may not be out of place, and, firstly, as to covering for the feet. From personal experience, we strongly prefer the thigh wading boots of indiarubber to the hide boots, as being much lighter, requiring no dressing, and if properly used, more comfortable. Two pairs are necessary, so as to permit the evaporation of the perspiration from the interior of one pair whilst the other is in use. Waterproof socks also tend very materially to preserve the boots, and, what is more, the health of the wearer, as they can easily be turned inside out and aired, thus keeping the foot of the boot dry and free from mouldiness. Wading trousers, of the same material or of tweed and rubber, are very convenient, as they can be turned inside out, and thus thoroughly dried. They also are much more convenient in deepish water, but necessitate the use of brogues.

One or two pairs of thick woollen socks should be worn under the rubber socks.

The body should be encased in woollen garments, upper and under, to resist the damp, as hatching-houses generally are, more or less, saturated with

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aqueous vapour. A pair of indiarubber gloves lined with wool will be found a most comfortable adjunct to the furniture of the fish-breeding establishment.

For the supply of waterproof articles we have long employed Mr. George Cording, of 125, Regent Street, 231, Strand, and 1, Albemarle Street, and can speak very highly of his productions.

The first matter of a special nature, which it behoves us to consider, is of necessity the water in which we propose to grow trout. The phrase "to grow trout," may seem an odd expression; but it is, nevertheless, perfectly correct. For, just as in good soil, well manured, and with favourable conditions of rainfall, etc., it is easy to grow good seed and secure a heavy crop, so in good water, with good eggs, and a liberal supply of natural or artificial food, it is easy to rear or grow trout to an extent, both of number and size, which will fairly astonish those who are unacquainted with the mysteries of trout-life.

To hatch the eggs we only require pure water, of which the hatching-house should have an ample supply. Whether this be derived from stream or spring is of small consequence, so long as the temperature be not liable to sudden changes, as these are likely to interfere with the gradual and even development of the embryo. On the whole, therefore, we are inclined to prefer spring water for our hatching operations. For rearing the fry when removed from the hatching boxes, we also require pure water; free from pollutions. But it should be well stocked with insects and animalculæ, as these afford a constant supply of natural food for the young fishes. It may be stream or spring water so long as these conditions are fulfilled,

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and the more nearly it approaches in its qualities to that in which the eggs were hatched, the nearer will it be to perfection as a receiving stream.

Any little stream possessing these characters will answer for rearing purposes, and it should have a moderate current, not too strong for the very young fishes, but not still and lifeless—ripple and pool alternating form, perhaps, the best home for fry, as they can then select their own quarters. To be perfect in this respect it should vary in depth from a few inches to two feet, as this supplies all that is necessary for the growth of trout to a considerable size.

Next in importance to the quality of the water is its quantity. This must be constant, as a stinted or unequal supply, especially at the hatching-house, is very injurious. Therefore, in planning an establishment, this point should be kept well in view, so as to make sure that, under no circumstances, and by no accident, can the supply run short. To have to stint and starve the eggs, or to think of every pint of water that can be scraped and saved, adds greatly to the troubles of fish culture, and detracts very much from the results, as eggs hatched under unfavourable conditions will never thrive.

The means of supply, again, forms a matter of some importance. If the water be derived from waterworks, it will, of course, only be necessary to have it laid to the hatching-house, and to see that the pipes are sufficiently large. Hydraulic rams are expensive; but if one be already on the estate, should it throw plenty of water, it may be used. However, there is always an uncertainty about rams, as the least thing puts them out of order, and it takes some time to induce

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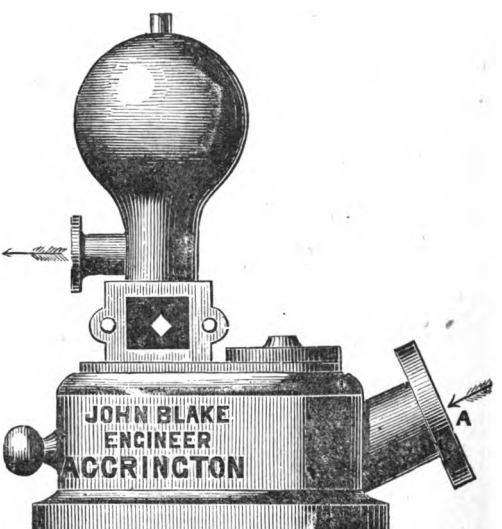
the machine to work when once stopped. For instance, an eel gets under one of the valves in the night and stops the machine, and has to be removed by unseating the valve; this empties the pipes, which then become charged with air, and it often takes some hours to force this out, and to obtain a fresh supply of water.

Since the above was written, many improvements in rams have been effected, notably by Mr. Blake, of Accrington, Lancashire, of which two forms are represented, the first a direct action machine, forcing up the water which works it: the second a ram which throws pure water, but is worked by a secondary, and not necessarily a pure supply.



DIRECT ACTION RAM.

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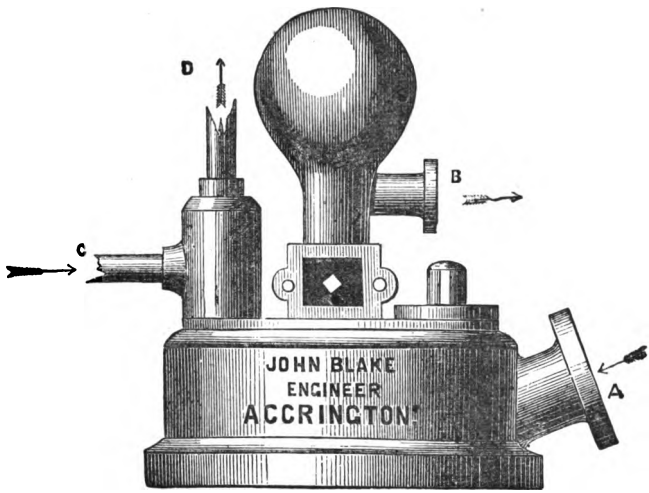

SECONDARY ACTION RAM.

Another good source of water-supply, personally tested, and not found wanting, is the hot air-engine, invented by Mr. A. K. Rider, of New York, and made by Messrs. Hayward, Tyler & Co., of 39, Queen Victoria Street, E.C., Luton, etc. This engine, though of course not self-acting like a ram, is very certain—easily kept in good order by any man used to the simplest machine, and goes for some time, if well stoked, without attention. On the whole, perhaps, it will be found better to work such a machine—applicable for any of the needs of water-raising, to those of the fish-house—than to put any trust in a ram, although the improved ram is a very valuable apparatus.

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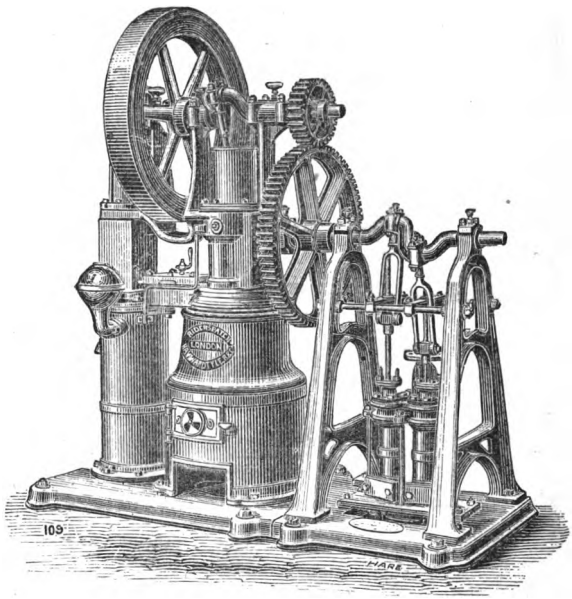

HOT AIR ENGINE.

Where we can get satisfactory pumping power, by hand, horse or steam, and a cistern of a sufficient size to hold thirty hours' supply for the whole hatching operations, we may be quite contented so far as water supply is concerned.

Lead piping may be used with perfect safety in fish culture, and junctions may also be made with india-rubber piping, a great convenience in altering or extemporizing apparatus; but india-rubber of the best quality only should be employed, as the chalky stuff sold by some firms will only lead to leaks and losses. Black or red rubber should be selected, and from a firm of standing.

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CHAPTER II.

THE HATCHING-HOUSE.

HAVING treated of the water supply, we next pass on to the hatching-house, which may be of brick, wood, or stone. Any out-building may be turned to use if only it be well built, well lighted, and well floored. It should be roomy, as vast numbers of little odds and ends, such as nets, tin cans, etc., are wont gradually to accumulate. A neat dry locker or broad shelf is very handy for nets, and cans should be arranged in nests, one inside the other, if possible.

A small stove by which to warm the hands will be appreciated. The cistern or cisterns may, if practicable, be inside the house ; but on no account should these, or anything else, be allowed to obstruct the light. A dark hatching-house is a misery and an abomination. As to the size of the cistern or cisterns, that must be regulated by the magnitude of the contemplated operations; whatever this may be, their capacity should be ample. They may be made of wood, lined with zinc or lead, or of galvanized iron.

A dry store-room within the mansion, or somewhere out of the way of thieves, rats, etc.—more especially visitors—where any secret operation, microscopic or other, may be performed, will be found of the greatest use.

In writing the present issue the author begs to say

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that he has entirely altered his opinion on filtration: it is perfectly unnecessary, and utterly useless, as will appear later on.

A good, well-trapped drain must be constructed in such a position as may be best fitted to receive the waste water after it has done its work.

All waste pipes, whether large or small, should be so contrived that all outlets shall be fully exposed to view. An open escape trough with the wastes from the various apparatus delivering into it will then be easily put right, should anything go amiss.

A thoroughly sound cement or asphalte floor will be found best in the long run; as, with a "squeegee," all the inevitable spillings are thus expeditiously swept away. Neatness, order and comfort result, and vermin are thoroughly excluded.

The lighting should be ample, either from skylights or side windows, as the construction of the building may require, and it is advisable to be able to cause a current of air to pass throughout the building when desired.

Odds and ends will accumulate, and shelves should be fitted up to receive them; and a strong bench, well supported, for pestle and mortar, meat slicer, etc., will be found useful. There should be a place for everything, and everything should be in its place. Something may be wanted in a hurry, and it should be at hand and in sight; there should be no rummaging and ransacking after it, as there is sure to be if one thing be piled on another.

A "round" towel may be suspended near the little stove for drying the hands, and hand-bowls are useful for many purposes. A mop for the floor is always

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handy, as however carefully the work is carried on water is sure to be spilled, and one is very liable to catch cold from standing on a damp floor.

If these cardinal points have been attended to, the intending breeder of fishes, whatever the size of his contemplated operations, may look around him with some satisfaction, as he may feel sure that however he may wish to alter the smaller details of his establishment, the main plan need not be materially altered or disturbed.

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CHAPTER III.

THE HATCHING APPARATUS.

IN this country troughs of wood, slate or terra-cotta are almost universally in use for this purpose, and it must be confessed that for the amateur, at any rate, they are unquestionably the best and handiest form of apparatus. It may be very different in large establishments, where many hundreds of thousands of eggs are annually received.

Having thus determined on the employment of troughs, the next question is the material best fitted to our purpose. Terra-cotta, slate, and wood have been mentioned, but we feel disposed to select slate for the use of the amateur as being very clean, not so liable to break, chip, or crack as terra-cotta or earthenware, and not so likely to leak as wood.

In the colder countries, where severe frosts prevail, however, wood will be found the best material, as, if well charred with a hot iron, and made of sufficient substance, it resists the action of frost far better than any other material. It must be of some thickness, or the intense cold may take effect on it. Where a man who can use tools is at hand, there will be no difficulty in the matter. About two-and-a-half to three inches of water is all that will be needed.

All hatching apparatus and accessories can be obtained from the Cray Fishery at moderate prices.

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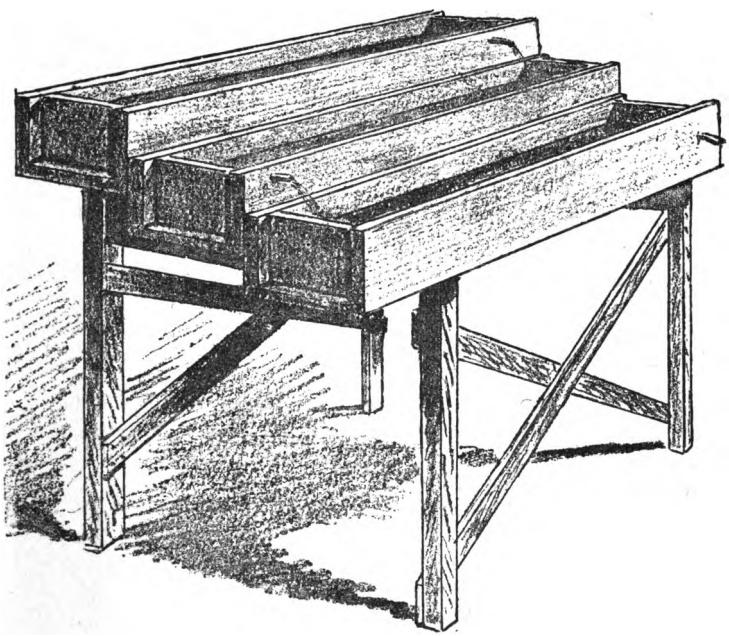

HATCHING BOXES.

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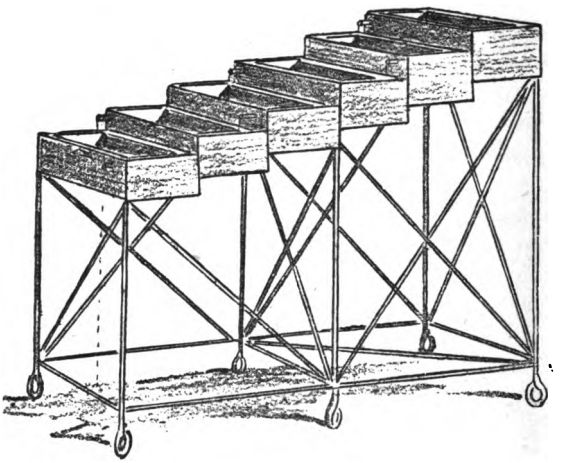

HATCHING BOXES.

The boxes can be arranged in tiers, one above the other, as in the sketch—or otherwise, at the will of the operator.

If wood be selected, it must either be charred, or well dressed with the silicate paint, made by the Silicate Paint Company, of Charlton, Kent, and Cannon Street, London, E.C. All kinds of varnishes have been tried, but none equal it in preservative power.

A good strong framework must be arranged to support the troughs, of whatever material they are constructed. It should resemble a staircase, the steps being of the width of the troughs, and arranged at such a height relatively to one another that the spout of each trough may properly deliver its water into that below it.

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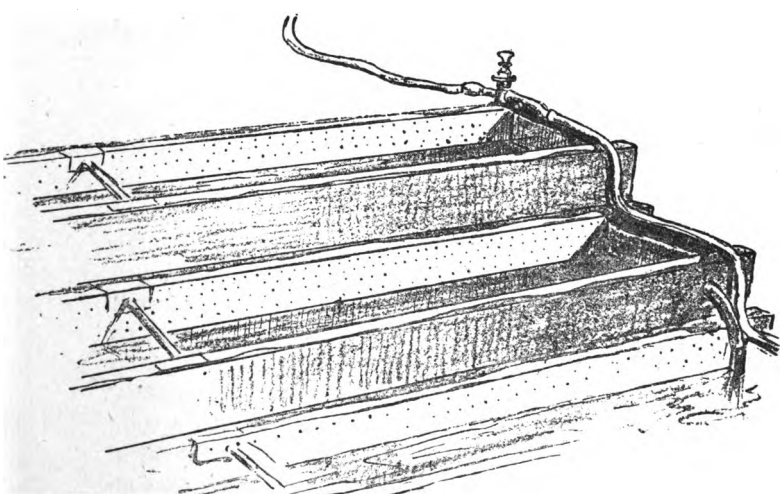
When filling up an apparatus a small "union" metal pipe should be attached to the water supply and carried along the whole length of the bottom edge of each trough, being connected by small gas unions with the supply pipe, as in sketch. The other, or free end, is squeezed together with pincers, and thus closed water-tight. Small perforations are then made with a fine-pointed awl or other instrument, and this gives a thorough aëration to the whole of the water in each trough, and an equal supply of fresh water throughout the apparatus. The spout of the bottom trough must be connected by indiarubber pipe, or otherwise, to a waste pipe leading to the drain, and of the same size as the spout.



PERFORATED ZINC INNER TROUGHS.

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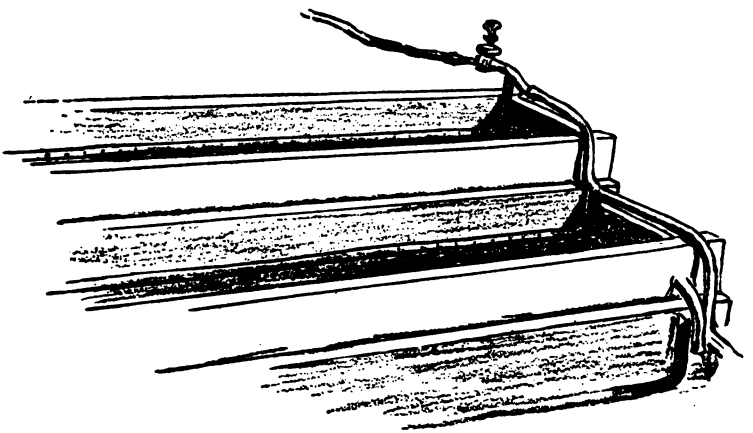

PIPES IN BOXES.

In slate troughs, or any other for that matter, the writer is perfectly convinced of the usefulness of perforated zinc as the best, safest, and most useful material to hatch on; others use a system of glass gulles, and attain success thereby, but the zinc saves the young fishes from falling into any dirt that may have accumulated in the boxes, especially in the absence of a filter, and it is, therefore, impossible for them to escape, unless there be a leak in the angles of the trough. The troughs are fitted by any competent workman with ease and celerity, or can be supplied from this or any other establishment. They must on no account reach the bottom of the main trough, firstly, on account of the supply pipe, secondly, to avoid

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filth which may have come in through floods or other causes. One inch clear from the bottom should always be allowed for these purposes.

These trays should be well washed in hot water to remove grease, dried, and painted with silicate paint before use.

Spouts of lead pipe are usually used for the outlets; they should be of ample size for the work that they have to do; this, however, like so many other things, must be left to the judgment of the person erecting an establishment. Some use tin spouts leading to a tin receiver.

Light wooden covers should be provided to exclude the light; or frames of wood, covered with blue calico may be used, one answering as well as the other; they must, in any case, be so arranged as not to interfere with the influx or the efflux of the water.

In the early days of pisciculture all used gravel, which had to be boiled, and then was not safe from fungus, of which more will be said hereafter. That pernicious system has been almost, if not entirely, given up by those who wish to attain the best results.

In addition to his other apparatus, the fish-breeder will require a few (one or two) glass tubes for moving and examining eggs and fry. No description need be given of them, as they can be obtained at the Cray Fishery. They are used as follows: The tube is lightly held by the third and fourth fingers of the right hand, in such a manner that the thumb can easily close the end; the thumb being pressed on the end, the bent part is thrust gently into the water towards the eggs or fry to be lifted. The thumb is then suddenly removed from the end of the tube for a moment,

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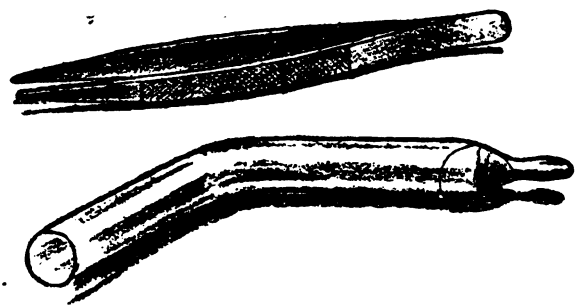
when the water, eggs, etc., will rush up. The thumb is again applied, and the other end of the tube raised



FORCEPS AND TUBE.

by a circular motion of the wrist, when its contents may be examined, and on removing the thumb may be returned to the trough or any other vessel. A few trials give dexterity in the use of this serviceable little piece of apparatus. A few feathers stripped to within an inch of the end, and used for moving eggs under water, are also of service. A pair of spring forceps or nippers will also be required for picking out dead eggs, etc. They should be about six or seven inches long, and have rounded points: they may be obtained at the surgical instrument makers' shops.

The above is all that will be required for those who buy eggs and hatch them out. Those who spawn their own fishes will require small flue or trammel nets of a suitable size to stretch across the little spawning streams up which the trout run to spawn. They will

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also need one or two landing nets fixed on to iron frames, fitted with light poles for handles. The writer uses frames, the bottom of the frame, or the side opposite the handle, being square, so as to scoop well under a fish; and by this means a pair of fishes may be frequently caught, as they are too intent on their own affairs to notice anything else. The irons or frames are punched with holes at intervals of about an inch, by which the net is attached to them with iron or copper wire An improved folding frame has lately been brought out, but is more expensive.

Two or three tin or galvanized iron foot-pans, to hold the fish when caught, and two or three stone-glazed or glass bowls, to act as spawning pans, will also be required, together with a light can to hold the eggs.

Whilst mentioning the spawning apparatus, it will not be out of place to refer to the boxes, which are handy recipients for unripe fish, and those which are ripe, but which it is not convenient to spawn at the moment. Their size may be made to suit the little streams, and the length may vary from twelve to twenty feet, as the fancy and requirements of the owner may dictate. They should have lids to keep out enemies. The ends of the boxes should be covered with coarse perforated zinc, to allow an abundant supply of water to pass through, as sometimes a large number of fishes may be in confinement at one time.

THE HOLTON BOX.

This apparatus consists of a square or oblong box, with wooden trays or frames fitted to the interior, the bottoms of which are covered with, or rather formed of,

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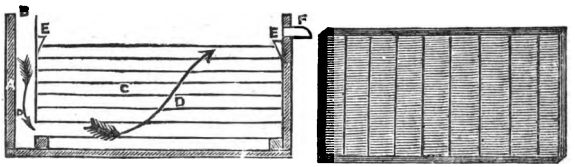
wire netting, of such a size that the eggs may rest on the wires, but that the young embryo, on emerging from the shell, can pass between the wires and swim over the edge of the box through an opening cut in the side of the top edge, and fitted with a lip or spout, into a receiving box placed under it. This has a sloping wire-gauze screen, very accurately fitted, to prevent egress therefrom.



THE HOLTON BOX.

This receiving box may be one of the "feeding" boxes afterwards described, and may be of any dimensions desired, in proportion to the number of eggs to be hatched, and the amount of water available. The trays, which should fit easily, are kept from floating by wedges, as shown in fig. The water is so arranged that it shall come in at the bottom and flow off by the spout at top ; the wires breaking the current and thus distributing the supply throughout the apparatus.

In starting the apparatus a small stream of water should run through it a few days before it is actually wanted for use, in order to season it and remove any taint from the paint or other dressing used for its protection ; black asphalte varnish being used in America, whilst silicate paint, of the Silicate Paint Company, Cannon Street, London, E.C., is the favourite for such purposes in England. When sufficiently seasoned, all

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the trays should be removed, the water syphoned out (unless a tight bung has been fitted in the bottom), all dirt, slime, and grease from the varnish or paint carefully sponged out, and the apparatus re-filled. The first tray is then floated on the surface, the eggs being carefully distributed on the top of the wires, which are arranged in parallel rows, with cross wires to strengthen them—and, if more eggs be at hand, a second tray is very gently laid on top of the first, so as not to disturb the first layer; this is filled in its turn, and so on, according to the supply. Finally, one empty tray is put on, and the trays are very gently and evenly sunk a little under the surface of the water in the box, and secured by wedges. It has been said that the water must enter at the bottom of the apparatus and flow out at the top, passing through the layers of ova: this may be effected by a side chamber, as in the sketch, or by a pipe carried down outside the apparatus and gaining an entrance by a well-caulked aperture in the bottom.

For keeping a number of ova in a small space, when fully "eyed," *i.e.*, when the eyes of the embryo are visible as black dots in the egg, this apparatus, if deftly managed, is very good; but it wants much manual dexterity and experience—probably that experience may be bought at too high a price by the amateur. In some cases there is a pipe fitted in the bottom with a portion of indiarubber pipe attached, and stopped with a wooden plug; so that if any of the young fishes fail to swim up with the current, which must not be too strong until all are on the eve of hatching, they may be drawn off by the hose into a vessel placed beneath to receive them.

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On the whole, it may safely be said that this apparatus, very valuable though it may be in the hands of a professional pisciculturist, is but little suited to the wants of the amateur; and should he take the advice of the writer he will give the Holton Box a wide berth.

At the Great International Fisheries Exhibition many very ingenious apparatus were exhibited by the various States represented; but they nearly all required professional skill, in some cases mechanical power, and were, in nearly every instance, more adapted for the service of a State Hatchery than for the use of private individuals, for whom, and for whose benefit alone, these chapters are written.

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CHAPTER IV.

SPAWNING.

WHEN cold weather fairly sets in, sooner or later, according to river and season, the trout run up into the small side streams, where shallow, rippling water and bright gravel are to be found, though many of the larger and older fishes spawn in suitable parts of the main current of the river— more especially in the case of the larger varieties of S. Fario, S. Thymullus, or Grayling, and the lordly Salmo Salar —sometimes they arrive in herds, sometimes in pairs —sometimes individually. The duration of the spawning time varies according to the various circumstances of the season, river climate, and many other causes. Sometimes the business will be concluded in a few days, so that diligent watch has to be kept, in order to secure the required amount of ova for artificial impregnation, at others it may extend over eight or ten weeks, batches of fishes following each other in succession, more especially in those places where fresh strains have been imported to cross with the original or indigenous one, in order to improve it either in size, beauty, gameness, or some other characteristic.

Before the spawning season is expected to commence, the stream should, as far as possible, be cleared of mud or any thing likely to prove injurious to the

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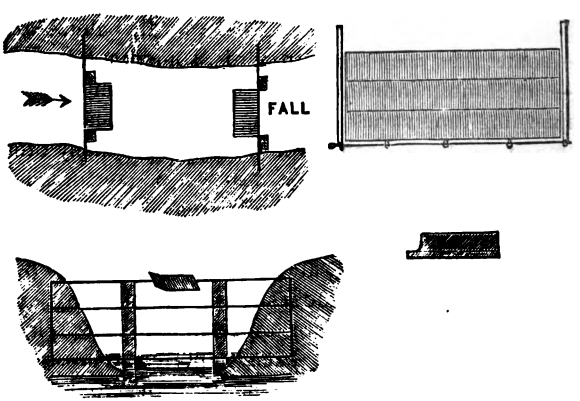
fishes or any eggs that may be deposited in the natural manner in the bed of the stream. Sufficient "weed," *i.e.*, aquatic plants, may be left at the sides (or on one side only) to afford shelter from herons, that at this time infest the places where spawning fishes are to be found. Boughs of trees, whin-bushes, or any *natural* shelters may be thrown across the narrow parts, so as to induce the fishes to stop near their work, and thus be handy for the performance of the artificial process, but all should be arranged with as much regard to a *natural* appearance as possible.

It may here be mentioned that Mr. Silk, pisciculturist to Lord Exeter, exhibited at the Fisheries Exhibition, London, 1883, a very ingenious fish trap,



SILK'S FISH TRAP.

by means of which the trout are induced to incarcerate themselves. Having used it for four seasons, the writer can speak most highly of its practical merits.

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It may thus be described:—At a convenient point in the stream, where floods do not materially affect the water level, posts are firmly driven into the gravel, and boards are nailed to these, the bottom one sunk some few inches to prevent anything burrowing underneath it, the ends projecting some foot or two into the bank at each end, and well clayed or sodded in. An aperture is then cut in the top board for the egress of the water, now dammed up a few inches, and chocks of wood are nailed to the inner edges of the aperture. These chocks have fillets nailed to their lower margins, on which rest a light grating of iron wire, fastened along the lower edge of the aperture, in such a manner that the grating can be turned up to clear it of leaves, weeds, or any thing else. As a rule the grating has rings forged on it and an iron wire, or very thin rod, passes through those and staples at each end, so as to form a sort of hinge. The grating lies above the aperture, its free end pointing up stream. The oldest wood should be used in the construction of these traps, so that nothing may tend to scare the ascending fishes.

This backing up of the water provides a slight fall below, which scours the gravel and invites the attention of any trout in the neighbourhood. They jump the fall with ease, and are thus caught, as, when attempting to return, the light iron grating proves a barrier to their escape. A sort of camp-sheet may be fitted all round to prevent their making burrows for concealment in the bank, and shelters may be provided if the inroads of herons should be feared. An alarm gun may also be used to warn of the approach of poachers. Those made by Mr. Burgess, of Malvern Wells, are

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good and cheap. The trap or traps should be carefully searched every morning, and the necessary steps taken, according as the fishes found are ripe or not. Where the trap is at the head of a stream, a piece of fine wire netting will arrest the progress of the trout upwards. Where some are expected to come down as well as up, a double trap may be set up, the two gratings pointing inwards and towards each other—so as to form stops at each end, both for ascending and descending fishes. It need scarcely be pointed out that the size of the trap, of the gratings, waterways, &c., must be governed by the size of stream, number of trout to be expected, and the numerous other considerations, for which it is impossible to give directions in a general description. Such details must be left to the judgment of the individual requiring the apparatus.

In the absence of a trap or traps the streams must be daily looked over when the season commences, to discover the presence of nests or "redds" as they are called. A disturbance of the gravel is a sure sign of work going on, though not necessarily of eggs being deposited, as the males often come up and stir up the gravel to entice the females, or, as one friend says "just to practice making nests;" as many of these preliminary nests have been carefully searched without finding any ova therein. However, these signs should call forth the greatest vigilance on the part of the pisciculturist, who should attentively note what goes on, and have all ready to secure his harvest of ova on the arrival of the females.

When this occurs, which may be easily discerned by the distended forms and duller colours of the hens, the nets must be got out, the waders donned, and the

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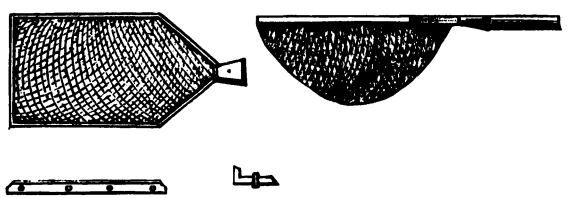
serious work of the season commenced. In searching a stream for trout it is always advisable to work upwards, as the mud or discoloration caused by wading passes down and does not interfere with operations higher up. Besides, after a length has been fished, it is only needful to shift the lower net above the other, after shaking and clearing it. A number of pegs are wanted to fix these nets. They may be carried in a pouch or in a belt round the waist. By the skilful use of a landing-net pairs of trout may often be scooped up, so intent are they on their reproductive functions.



LANDING NETS.

The portion fitted to the haft or handle has a male screw which fits a corresponding female screw on the net-frame, so that various meshes of net may be kept "bent on" to the frames, and it is then only needful to unscrew one frame and put on any other, should special work have to be done with them. At first the frames and fittings were made to taper from the haft to the front bar, but, as the strain comes on the latter, they are now made of the same thickness throughout. Cast-iron has been substituted for gun-metal, with a considerable saving in cost and no disadvantage as to efficiency. Sections showing the form of frame and manner of drilling are appended. But however effi-

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cient the pisciculturist may be in the use of a landing-net, it is always advisable to have stop-nets to check the escape of the fishes.

If there are any holes under the banks made by water-rats they should be examined, as trout frequent them. If the net will not reach right to the end of the hole, the arm must be thrust in, and the hand will often find a fish at the end of the opening: the hand is passed gently along so as to be able to grasp the fish just above the tail, it is then suddenly closed, and the fish "tailed out" on to the bank, and put into a tub or foot-pan of water whilst others are sought for.

When all have been caught, the sexes should be determined, and the unripe fish, if any, transferred to the box mentioned at the end of the previous chapter.

The sexes are readily distinguished, as at spawning time the eggs will be felt in the spawner or hen fish, whilst in the male the milt being a liquid, is easily recognized. In taking a fish out of a net, if in anything like proper order for spawning, a few eggs or a drop of milt will generally appear, even with the gentlest handling. Unless a fish is thoroughly ripe it should be kept in the box till it is so, as unripe eggs or milt are quite useless for hatching purposes.

When the sexes are determined, and the ripe fish separated, we have to consider the proportionate numbers of each sex. Some days we have more cocks than hens, others the reverse, or even all hens and no cocks. As one cock will, if "full," suffice to impregnate two, or even three hens, it is advisable, if possible, to reserve a cock or two in case of being short of milt on a future occasion.

Having mentioned all this, we will suppose that

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proper arrangements have been made, and that the actual process of spawning is being carried out. The spawning pans are laid on the ground or on a box, tilted a little to one end by a stone or stick, *quite dry*. A hen fish is taken out of the tub and allowed to kick about for a few seconds to render it less difficult to hold, and induce it to yield its eggs more freely. The operator then, with a piece of flannel, holds the head of the fish carefully, but firmly, in his left hand, and his assistant keeps it extended by grasping it just above the tail, but below the vent, a piece of flannel being used to secure a firm grasp. The fish is held sideways, with the vent as near the bottom of the spawning pan as possible, and the operator with his right hand strips the fish. Some operators begin at the upper end of the ovary, which extends nearly to the pectoral fin, and carry the pressure gently, but quickly, to the vent, only using the thumb and fourth finger. Others first press out the eggs nearest the vent, and then work up the ovary, squeezing the eggs out portion by portion until all are removed. So long as no backward pressure is allowed, which would injure the fish, this is a good method.

Whatever plan be adopted, it must be carried out rapidly and gently; if the fish be faint, or refuses to yield all its eggs, it must be put into a vessel of fresh water for a few minutes, whilst another hen is stripped, by which time it will probably have recovered, and can be completely emptied. When one or two hens have been stripped, the cock is held over the eggs, and his milt taken in the same way, except that the testes or milt bags do not extend so far up the fish as ovaries; in fact, not much more than half-way between the vent

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and pectoral fins. When spawned, each fish should be carefully returned to the water, and, if faint, supported between two stones, head up stream, until able to look after itself. When the milt has been taken, the pan should be tilted a little so as to mix the milt with the eggs, and then left a minute, after which a little water must be added, enough to cover the eggs, and the pan set aside until the eggs (which at first cohere very strongly) have completely separated. The tin can should be filled with water, and the eggs poured into it from the spawning pan. They at once sink to the bottom, and the superfluous water runs over the side. The separation of the eggs takes from ten to twenty, or even thirty minutes, and this interval may be used in spawning other trout, if at hand.

Some operators spawn all their fish in one pan, but we think the course above suggested preferable for many reasons. The eggs of two hens are, in our opinion, enough to have in one pan; but, if short of milt, of course if there are three, or even four hens to one cock, all must be spawned in one pan, or kept in the box.

We should advise anyone intending to spawn fish to have a look at the casts in the Museum of Fish Culture, South Kensington. He will there see exactly how the organs of generation are placed in the salmonidæ, and will gain a good deal of useful information on that and other points by his visit.

By the old, or wet method, now almost, if not quite, obsolete, the fish and the hands of the operator were plunged in a vessel of water, the eggs taken were very carefully washed, and then the milt was put into a

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separate vessel of water and mixed with the eggs. A hatch of sixty per cent. was thought very good in those days, and so undoubtedly it was, if the result be regarded by the light of our modern knowledge. The thing would seem to be almost impossible, but for one fact lately made public by Mr. Jackson, of the Southport Aquarium, whose microscopic investigations of the movements of milt in water are very important. He tells us that when milt finds itself in water the spermatozoa distribute themselves throughout it, each keeping an equal distance from the other, so as to miss nothing. In fact, he compares the appearance of these objects, seen in the field of a microscope, with the patterns of shot, as advertised by makers of close-shooting guns; but points out that the regularity of the distance of the spermatozoa from each other was almost, if not quite, invariably observed, each one maintaining its position relatively to the rest, as the milt spread through the water. This is a matter of the greatest importance, and should receive further attention, as it leads us to a clearer comprehension of the manner in which eggs are naturally fertilized in a stream, and cannot fail to be of great interest to the student of physiology.

We have said that under the old régime sixty per cent. was thought good. By degrees, however, less water was employed, and the result was found to justify the innovation; so that gradually one vessel was substituted for two, and very little water was used. The veteran pioneer in pisciculture, Seth Green, found this out many years ago, as Mr. Stone tells us in *Domesticated Trout;* and, though ready to impart any other fact to others, he carefully kept this to

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himself, saying that it was as good as a patent to him, and so it was. However, before the advent of the Russian method, men on this side of the Atlantic had come to the same conclusion, and eighty per cent. of impregnation had been reached; aye, ninety also, but only by old and knowing operators. By the new process the merest tyro may obtain ninety or ninety-five per cent.

The following account, showing the discovery and superiority of the "Russian" or dry method of spawning, was printed in the *New York Citizen and Round Table*, May 27, 1871, and published in *Domesticated Trout*, by L. Stone:—

"In his experiments, M. Vrasski had followed the counsels given in French and German works on pisciculture, but the results obtained were far from being brilliant. In reality, at each hatching he obtained but an insignificant number. 'From many thousands of eggs,' says he in a letter, 'there were only some dozens of young fry. The rest of the eggs were lost and spoilt for want of being impregnated. I have, however, followed with scrupulous exactness all the directions given in the manuals for fecundation.' In the autumn of 1856, M. Vrasski was occupied with the microscopic examination of the eggs and milt, and kept a journal in which he registered the least circumstances and incidents relative to each fecundation that he effected. Two months of persistent efforts brought the desired results. The journal and the microscope proved to him that the cause of his failure proceeded precisely from the exact observation of all the counsels of the foreign manuals. It is necessary for fecundation that the spermatozoa of the milt of the male

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should penetrate the eggs of the female. In order to do this, the manuals recommended receiving the eggs in a vessel of water; afterwards, to receive in another vessel of water the milt of the male; and, lastly, to turn the diluted milt on to the eggs. By his journal, kept with scrupulous exactness, M. Vrasski convinced himself that the fecundation was so much the less complete, according as the mixture of the milt and eggs had been the most delayed. If ten minutes elapsed between obtaining the milt and the mixing of it with the eggs, the fecundation failed almost entirely. His observations, and the microscopic researches of the eggs and milt, showed that:

"First. When received in water at the moment of issuing from the fish, the eggs absorb the water, and preserve the power of being impregnated only as long as this absorption is not finished: that is to say, during a half hour at the utmost. Once saturated with water, the eggs do not absorb any spermatozoa: but if received into dry vessels on issuing from the fish, the eggs remain, on the contrary, in a neutral state for a lengthened time, and do not lose the power, when placed in water, of receiving the spermatozoa.

"Second. The spermatozoa of the milt, in falling into the water, commence immediately, with much vigour and rapidity, to make movements, which only last, however, for a minute and a half, or two at the most; when this time is elapsed, only in some few spermatozoa can their be seen particular movements and agonized convulsions.

"When, at the issuing from the fish, the milt is received in a dry vessel, it does not change for many hours, and during this interval the spermatozoa do not

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use the power of beginning to move as they do when placed in contact with water. Closed in a dry phial, and well corked, the milt preserves its impregnating virtue during six days.

"From these observations, as also from the fact that the eggs as well as the milt are obtained slowly, their entire mass not being able to issue at once, M. Vrasski arrived at the conclusion, that when they were received in water, the greater part of the eggs attempted to saturate themselves with it, and the spermatozoa ceased to move almost before it was possible for the fish-breeder to mix the eggs with the diluted milt. M. Vrasski then adopted the system of dry vessels, and turned the milt on the eggs directly he put them in water. The success was complete; all the eggs were impregnated without one exception."

The above speaks for itself, so that all we need further do is to congratulate M. Vrasski on his success, and thank Mr. George Shephard Page for publishing them in America, whence we have received them through the Rev. L. Stone, an eminent pisciculturist.

To revert to the eggs which we left in the egg can. This must be carried home carefully, and its contents distributed in the troughs by the aid of the glass tube; the covers are then to be placed on the troughs, and a good supply of water turned on. In arranging eggs in troughs it is always advisable to fill from the lowest upwards, as by this means the shells of the first hatched lot do not interfere with those eggs which hatch later on.

The above remarks apply only when the eggs have to be carried but a short distance, and are not subject to the jars of rail and carriage transit. Where this is

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inevitable, another course of procedure must be used. The ova should be carried in a light, shallow wicker basket, in the bottom of which a layer of moss has been evenly spread; then a piece of fine "tiffany" or cap-netting is laid over it, and the eggs laid on that in a good thick stratum or layer, three or four deep: this is covered with another piece of the same material, and moss put over it, the process being repeated till the whole are packed, or the basket is filled,—finishing off with a layer of moss and a good sprinkling of water to keep all moist during the journey. It will be found necessary to soak the tiffany or other stuff used in two or three waters, in order to remove all the dressing from it, as this often contains noxious substances; it may be wrung out and dried, so as to minimize the weight on the outward journey.

The basket or baskets used should have a "fold-down" handle, and be sufficiently shallow to go under the seat of a railway carriage; or, by carrying with him a sheet of thin india-rubber cloth, the pisciculturist may carry the basket on his knees, without fear of damp or cold to himself, or injuring the seat of carriage.

As to the number of eggs to be allowed to a square foot of trough, to secure perfect health and strength, we should recommend that the number should be restricted to a thousand, which is a perfectly safe number; and is, after all, amply sufficient for the private hatching-house, in which quality, not quantity, is the great object in view.

In arranging eggs a feather may be of great service, if lightly used; as, by its means, the eggs may be easily separated, so that no two may touch each other. They will hatch out better for this, as each egg will

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have a current of oxygen-bearing water passing all round it, which cannot be the case when all the eggs are left in heaps.

Eggs are a favourite prey of a number of enemies. Some fishes prefer them to any other sort of food, and rats or mice will eat them greedily if they get a chance. Care should therefore be taken to keep the troughs closely covered if peril be apprehended from the latter source.

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CHAPTER V.

HATCHING.

IF everything were quite right, hatching would be a very easy affair. If every egg were impregnated, and no enemies existed, the fish-hatcher's labours would be light indeed; but this is not always the case, especially at first. If, however, the directions about the spawning be faithfully carried out, and the hatching apparatus fitted as above advised, we may safely anticipate good results.

When the eggs are once placed in the hatching troughs, they must remain there until the eyes of the embryo are distinctly visible through the shell. When thus "eyed" they may be moved carefully, if needful, and even packed in moss and sent long distances; but, excepting when sending a present of eggs to a friend, there will never be any necessity for doing so in the private hatching-house, and the eggs should be left at rest until hatched out.

They must, however, be daily examined, and all dead eggs carefully removed with the forceps or nippers; and great care must be taken at first in doing this so as not to injure a living one near it, and hence the benefit of spreading the eggs at first, and once for all, with a feather or otherwise, when laying them in the trough.

If kept in heaps the feather is used to spread them, and thus the odds are that a second heap is formed, and the daily examination is much prolonged, to say

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nothing of the bother of always having a feather in hand when examining the eggs.

The tyro will naturally ask, "How am I to tell a dead from a living egg?" Let him have no anxiety about that, as a dead egg can be told in a second, even by an inexperienced eye. A good living egg is translucent, and has a beautiful bloom on it like that of a ripe Muscat grape; a dead egg is opaque and white, and when once seen can never be mistaken.

These dead eggs should be picked out carefully every day, as, if left in the water, a species of alga grows upon them, and spreads over the living eggs in their vicinity, and by killing them would, if left alone, in time do incalculable mischief. This is called "Byssus."

Every care, therefore, should be taken to secure a perfect impregnation, as the more successful it is the less labour will there be in removing blind eggs; and this labour is of no pleasant kind, as the work has to be done with the hands, dabbling in the water very often with the air below the freezing point, and the running water very little above it.

If, however, ripe milt and eggs have been used, and all has been done well, the labours of the day will be very light, and the sense of success will buoy up the heart under any little hardship or difficulty.

It has been said before that the eggs when once placed in the box or trough must remain undisturbed until fully eyed, if not hatched. Too much stress cannot be laid on this point, as, if moved before they have eyed out, fully one-half of the eggs are sure to die. It seems strange that what kills one egg will not destroy another; it may, however, we think, be attributed to the greater natural vitality of some eggs than of

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others. Some will, perhaps, attribute it to a faulty impregnation; but, we think, under the dry system this can hardly be the case. Whatever the theory used to account for it, the fact remains; and all care and provision should be taken to prevent a necessity arising for taking so perilous a step.

Should a deposit of sediment occur, it need not be regarded, as it will do no harm whatever. When the eggs are thoroughly "eyed," and the dark eye-spots are seen quite distinctly when a few eggs are shaken up in the glass tube, the water decanted and a fresh quantity admitted, they may be safely washed (just for the sake of appearance). To do this a small garden syringe may be employed: it is filled with water, and, the rose being kept under water, the piston is gently pushed down and the process repeated; this drives the eggs into a heap at the other end of the trough; the zinc inner trough can then be lifted out and tilted over a vessel of water; the eggs can then be washed under a tap, the supernatant water poured off, and the process repeated until every egg is clean; zinc and trough may be cleaned out and the washed eggs put in again.

Should the purchase of "eyed ova" be made, any fresh variety be introduced, or a greater stock be required than the river itself will supply, they will generally be received packed in boxes, either loose, in wet moss, or enclosed in folds of muslin or mosquito netting, with layers of wet moss above and below them.

The tin has holes in the bottom, and must be put into a vessel rather deeper than itself, and water must be added; when, on removing the lid and top layer of moss, the water will work up through the holes in the bottom and cover the eggs. If these be loose, as

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much as possible of the moss and *all* the heavy parts of it having been removed, the whole arrangement is to be carried under a tap and a gentle stream of water directed to one side of the vessel; this will drive over the moss, with the assistance perhaps of a feather, and the eggs will settle in a state of purity; they may then be quickly transferred to a trough, or be washed further in any other vessel, as may be convenient.

When muslin is used, the moss is cleared away till the muslin appears, and all moss adhering to it is removed; then the edges are folded together, and the whole lifted out and skaken, and gently separated in a vessel of pure water; the eggs sink, and any floating moss may be driven over as before, after all the layers of eggs have been shaken out in the water.

In sending eggs away the reverse operation is performed. The tin is sunk in a vessel of water, then a layer of soft, well-washed *Sphagnum* moss is put on the bottom, then one fold of muslin, then the eggs are carefully distributed over this with a glass tube, and arranged with a feather or thin glass rod, so that no two eggs are in contact, then a second fold of muslin, and the operation repeated as before till completed. Next, a good thick layer of moss is put on and the box drained; then, should the moss have sunk down, it is topped up with a fresh layer to completely fill the box, and the lid is put on. Finally the tin is packed firmly in sawdust, in a wooden box, the lid screwed down, and sent off.

In estimating the number of eggs in a fish, the rule is that one thousand eggs go to a pound of weight. Thus a half-pound fish will have five hundred, or nearly so; a pounder, one thousand; a two-pounder, two thousand, and so on.

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American trout eggs take very nearly, if not quite, the same time, under similar conditions, to hatch out as those of this country. Mr. Seth Green, no mean authority, says that in water at 50° Fahr., the eggs will hatch in fifty days, and every degree warmer or colder makes five days difference, the eggs hatching earlier in warmer, and being retarded in their development in colder water. Mr. Green also says that if the eggs hatch in fifty days, the yolk sac lasts thirty; if hatched in seventy days, the sac remains forty-five. We are indebted to Mr. Stone for this information, which will be found generally reliable, though subject to alteration or modification by circumstances.

By the kindness of Messrs. H. Ainsworth and Livingston Stone, of the U.S. Fish Commission, here follows a series of "times of hatching, etc.," which will be found of equal value in this country:—

Average temperature of water.	No. of days to first formation of trout.	No. of days to formation of eyes and red blood.	No. of days to hatching.	No. of days after hatching to feeding.
o				
37	43	81	165	
38½	29	64	135	77
39	28	62	121	
40⅕	27	54	109	60
41	21	49	103	
42⅓	19	42	96	
43⅛	17	37	89	46
44	16	34	81	
45½	15	31	73	
46½	13	29	65	
48	11	26	56	
50	10	23	47	30
52	8	18	38	
54	7	15	32	

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Seasons vary, and times of spawning vary (though within comparatively narrow limits), consequently no hard and fast rule as to time of incubation can be laid down. Late eggs may very likely hatch in a far shorter time than early ones, as the water at the end of February, and in March and April, will be warming up, and consequently the development of the embryo will be more rapid.

No one, however, should be anxious to see the eggs hatch out quickly; the more slowly they hatch the better, healthier, and stronger will the fish be. If the eggs have "eyed" out strongly, and the form of the fish be dark and lusty in the egg, let no one have any anxiety about earliness of breaking the shell.

Some day or other a little dark-looking thing will be seen in one or other of the troughs, and an attempt be made to remove it with the nippers, when the little object will wriggle away and seek protection amongst the eggs. These at this period appear much swollen, and of a tint and with a bloom like a ripe peach. On examining the little stranger in the glass tube, it will appear as a mere threadlike body, with two very prominent eyes, resting on a round yellow ball of oil. On using a lens it will be seen that the blood-vessels are spread out into and over this vesicle of oil or yolk, whence the necessary food is obtained in this, which is called the "Alevin" stage of a trout's existence.

Nature thus caters for the young fish for from a month to seven or eight weeks, according to temperature; heat accelerating and cold retarding the consumption of the oil in the vesicle and the development of the body. Having all its needs supplied, it rests pretty quietly for a day or two, and only wriggles at

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intervals; but about the fifth day from the general hatching out of that batch of eggs, a general desire to hide becomes manifest. Accordingly in every angle of the trough, except where the water is disturbed by the stream falling in from the trough above, there will be seen a writhing, wriggling mass of alevins, each trying with might and main to hide itself under its neighbours, all heads directed towards the corner, and the strongest youngsters lying in it, until forced out by superior numbers; and this goes on for some time, it may be a fortnight or three weeks, according to the temperature of the water. During this time the alevins will have gained greatly in size, grace and symmetry. They will have become wonderfully active, swimming rapidly up and down the tube, and their fins will be seen to have grown, and the tail developed to a surprising extent. The umbilical sac or vesicle, too, will have half, or more than half disappeared, having been gradually absorbed during this period, to yield the necessary nourishment for the evolution of the various organs of the fish, which were at first in a rudimentary state.

After this they gradually separate, leaving the corners of the trough and covering its whole length at pretty even distances, having the appearance, at a distance, of extra thick black pins. They do not move much now; however, on looking over them a few will be seen in motion at intervals; but it can scarcely be realized that these seemingly impotent creatures will, in a week or two, be in incessant motion; yet such is the case, as the rest appears to be needed for the complete development of the swimming apparatus; when this is duly furnished, they will be seen to rise spon-

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taneously in the water, and stem the stream flowing over them; though they still carry a vestige of the umbilical vesicle or sac.

There is hardly a more enjoyable sight in store for the breeder of trout than to see a trough full of young trout balancing themselves in the water, with every fin in action, now stemming the stream as it runs in from above, and then retiring to a quieter place to recover themselves after the exertion.

Now, and for some time after, a great tendency will be manifested by the young fish to go down stream, especially at night. The writer has almost emptied the bottom trough of a series, and next morning has found it crowded with others. Every effort and much ingenuity will be evinced by the fish; therefore the greatest care should be taken to see that no chance fault or flaw is left uncared for in the perforated zinc or outlet screen, or great will be the loss, as the trout will follow each other like a flock of sheep, if once an opening be discovered. This is a very pleasant time for the fish-breeder; the fish require no food as yet, and very few die; so that he has only to look over his stock every day, to pick out any chance dead ones carefully, and to admire the wealth of life moving beneath his eyes.

Before closing this chapter, to treat of the method of feeding and rearing the completely formed fish, we think it advisable to repeat two or three of the chief points in hatching, on which success depends.

Have everything in perfect order before commencing operations, and the water running gently through the apparatus a day or two before eggs are expected. Use only freely flowing eggs and milt, use a sufficiency

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of the latter, leave eggs and milt together for a minute or two, and, on adding water, let the eggs separate perfectly before moving.

On no account move eggs about till well "eyed," and pick out dead ones daily.

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CHAPTER VI.

REARING.

WHEN the umbilical sac or vesicle has quite disappeared, and the young fry can swim actively about, the time will have come for feeding to commence.

No one need have any anxiety as to how soon to offer food, as the fry will plainly show when they are inclined for it, by darting at any little insect or other small object floating on the water. Throw a few gnats on the water, if there be any uncertainty, or cast in a *very little* finely chopped liver, and if ready for their meal the fry will cause a total disappearance of gnat or liver in a marvellously short time.

It is wise at this time daily to test the most forward lot in this manner, as some of the fry are sure to be more forward than others and require food sooner. Whenever a lot of fish show themselves ready to feed they must have a regular supply of it daily at proper intervals.

Before the return of Mr. Silk, Pisciculturist to Lord Exeter, from America, the question of rearing the fry was a most difficult one; anybody could hatch, but very few succeeded in rearing with ease and certainty. Mr. Silk has successfully solved the difficulty by his feeding-box.

This consists of a long wooden trough with a small chamber at the head for the water to flow into, with a slip of tin nailed on its effluent side, so that the

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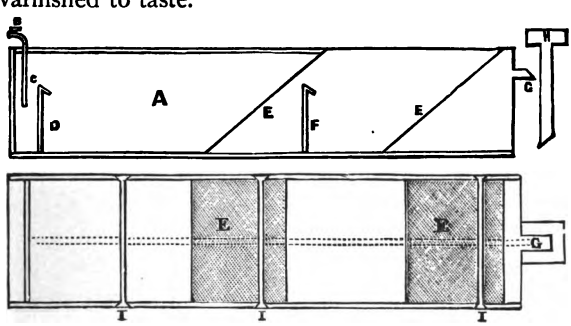
water flowing over has a clear run; there may be one or more divisions for the separation of species, each division—and, if none, the outlet—being guarded by a fine perforated zinc screen, securely nailed to fillets of wood and the bottom of the trough. These fillets slope with the stream at an angle of about 40° from the horizontal; and the spout, of metal, is securely fitted and water-tight. The interior of the box is dressed with black varnish or silicate paint. The box is strengthened and bound together by cross-pieces dove-tailed in at the bottom, which is fitted by tongue and groove about one inch from the lower edge of the boards which form the sides; the ends are also put in after the same manner. Cross-bars are also dove-tailed in on the top edge, and on these rest the lids, which are merely laid on, and so cut as to leave about one inch in the middle open for light and air, and as an aperture for feeding. Fifteen inches will be found a convenient width.

The exterior and lids may be painted or stained and varnished to taste.



FEEDING BOXES.

A box, B tap, C rubber-hose, D water chamber, E zinc, F division, G outlet.

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The above sketches represent a box in section and plan, six feet long, with one division, which is not quite in the centre, as the side next the in-fall will hold more fry than the other, as the water is all fresh. Rubber hose should be attached to the end of the tap to exclude air. This may seem absurd, but it will be found of great value in practice, for too much oxygen is almost as bad for the young fishes as too little. When there is a division in the box the back water board, if used, should be so placed that the hand can be passed freely under the zinc to clear away excrement and dirt, or it will ferment and breed a pestilence amongst the fry below.

Mr. Silk places his boxes on a very gentle slope, but we cannot see any object in so doing; so we advise that the box be set horizontally on tressels or other suitable supports. Water should be run into the box some days before it is used, to season it, and also to cure any "weeps" or leaks from "shakes" in the wood or other causes.

When thus ready for use, and the fry are fit to turn into the feeding box, if hatched on perforated zinc trays, all that has to be done is to take the trays, if short ones, and invert over the box and wash any adhering fry off the zinc with a hand-bowl or syringe; if long trays are used, they are tilted end up in a pail of water and the fry washed down into it. The pail is then similarly emptied into the box, the lids put on, and the fry should be left to settle down comfortably in their new quarters. Gentleness, combined with quickness and care, are required in the operation.

When the fry show by their actions that they are ready for food, the next thing is to cater for them.

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Mr. Edon, of the Buckland Museum, used to give "blood-worms" from the mud of the Thames; but these are now very difficult to procure, very expensive, and in many waters soon die; and when dead give forth a most sickening and offensive odour—one, too, that is likely enough to bring in its train a great loss amongst the fry.

Mr. Silk advises raw liver as best for the young fishes, and there we agree—for it is cheap, can be got almost anywhere, and forms a most nutritious, palatable food. The mode of preparation is as follows:—A Starrett's Patent American Meat Chopper should be provided; one can be purchased of the Manager of the Cray Fishery. It should be fixed firmly by clamps or screws to a stout bench or table, and there kept for use, as it will be in daily requirement, at any rate for some time. It consists of a fly-wheel, actuated by a handle, which works a "walking" beam, raising and lowering a broad knife, and at the same time, by an ingenious mechanism, causing the revolution of the cylindrical metal vessel, with hard wood bottom, in which the substance to be chopped is contained. This vessel has water placed in it, and the liver; the knife is then worked by the handle till the liver is reduced to a fine pulp, almost impalpable. This operation takes some time. When thoroughly performed, the bolts at both ends of the walking-beam are withdrawn, the knife is raised out of its place and washed, the cylinder taken up from the iron which acts as its central pivot, and its contents removed to a box, which stands over an empty pail, the cylinder is washed and dried until required again, when it is replaced. The box to which the liver has been trans-

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ferred has a bottom of No. 5 perforated zinc (Braby gauge), and the fine particles are washed through, the mass being stirred and kneaded by a wooden spatula or paddle. Some pisciculturists allow the supernatant liquid to clear, and then syphon it off; others stir the whole mass with the spatula, and feed it to the fry as it is, at any rate at first, as they hold that the keen, microscopic eyes of a young fish can readily perceive fine particles which, to our unaided vision, are perfectly invisible.

Other people use beef-steak, which they rub with their fingers through a strong sieve-like frame covered with perforated zinc; it comes through in minute worm-like masses, and is fed to the fry without previous contact with water. Either method will be found satisfactory at first; but as the fry grow larger their food may be increased in size; then the meat-chopper comes into special use. The liver is cut to what is deemed a suitable size, and the box or strainer over the pail is fitted with coarser zinc, say No. 6, and by-and-bye No. 7; the liquid is now decanted, and the solid palpable food given, as before, on the end of a spatula, feather, or otherwise, until the young fishes are fit to turn out into the grated stream or open river, according to the plans of the pisciculturist.

These boxes are of the greatest service in fish-breeding, as by their means the fry are kept in safety from enemies, regularly fed and looked after, and grown on to a size at which they are more or less able to take care of themselves.

There are, however, two points to be kept in view in their use; namely, to avoid excess of air in the water, modulating the flow according to the strength

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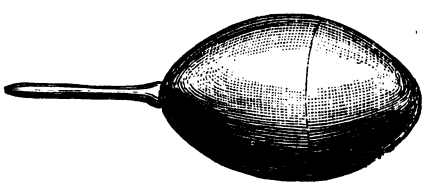
of the fry, and to keep the boxes perfectly clean. Syphon out all dirt, excrement, uneaten food, or anything likely to cause putrescence, which if left where it falls is certain, especially in hot weather, to produce gill-fever, or some other fearful malady.

Therefore syphon out everything that passes a screen; and, with the bulb-syringe, suck up all dirt inside the box itself. Its use is as follows: squeeze the bulb as empty as possible; then plunge the wooden nozzle under water near the substances to be removed, and allow it to fill gradually, rapidly moving it about until all has been cleared, or the bulb is full, when it is to be emptied into a vessel and the process repeated.



BULB SYRINGE.

As to times of feeding, little and often should be the rule, just as with chicks, especially at first. Give them just as much as they can demolish at once, and no more; an hour or so after feed again. Experience, and experience only, will show the right quantity. Never give sour food, or any that is the least tainted.

As the water warms more may be turned on, and any method of shading or cooling the house or place in which the fry are that may suggest itself, should be adopted.

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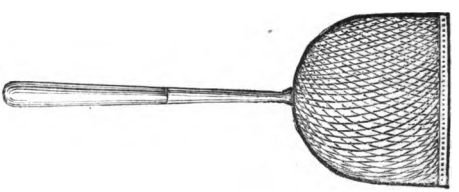
Some of the fry will be found to thrive better than others in the same box or division; these have a tendency to bully their weaker brethren, and fin-nibbling, or even cannibalism, may be the result. They should, therefore, be removed to a place by themselves, or else turned out into the stream. They may be hunted down and caught in a small hand-net, made of cap-netting sewn to a wire frame, which is fixed in a tool handle.



HAND-NET.

A box, as figured above, say 6 feet long by 15 inches wide, will hold from 15,000 to 20,000 fry *at first*, but as they grow more space is required, and they must be thinned out, either into other boxes, or in such other way as the requirements, judgment, and discretion of the pisciculturist may indicate.

By such a system of management fry may be kept and made to "grow like weeds" until July, when the ponds or streams will have been prepared for their reception, and, as gardeners phrase it, "they are ready for a shift." When turned out, if the commissariat has been well-organized and looked after, many of the fry will be two inches long—some more, some less—but all will be fat and well-grown.

As to the precise time for turning the fry into stream or pond, much depends on the temperature of

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the water, the aspect of the place where the boxes are situated, the convenience of the rearer, and many other considerations; therefore no hard-and-fast rule can be laid down; but it may safely be stated that when the water approaches 60° F. out they should go; and all needful preparations should have been made some time beforehand, so that any defects may be discovered and corrected before the breeder turns his precious infants into a new sphere of life.

Before, however, an open stream is used for fry, all the weeds and mud should be removed and the height of the water carefully noted, as weeds have a great tendency to heap the water up and give it an artificial height which is immensely above the natural level when cleared out effectually. The writer, at the moment of writing this, has but just returned from visiting a stream of this sort, which, instead of holding a foot or more of water, has not more than three inches of depth, and in a dry season would require to be dammed up by artificial means.

If a few little falls can, under any circumstances, be made in the stream, they will be advantageous to the fry, as they like strong, rippling water; these falls also tend to oxidize the water by exposing it in thin films to the air, and have a neutralizing effect on any impurity that may by any chance find its way in. Water plants have this effect also, and should, therefore, be encouraged to a moderate extent, especially as they also act as shelters or hides.

The woodwork required for the screens at each end of the water consists of a "sole-plate," a good solid slab of timber some six feet longer than the width of the stream, having two strong uprights mortised into

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it about three feet from each end, and carrying grooves to receive the slide on which the zinc or iron screen is fastened. These uprights are braced to the ends of the sole-plate by "struts" or buttresses, with planking nailed to them so as to form "wings," which extend into the bank and prevent the water working round instead of going through the perforations of the screen, a thing which, in their absence, it is sure to do. A firm bottom is selected, and branches are made on each side of the bank to bed the wings on. The bottom is levelled, and the sole-plate is bedded carefully on it; and the stones and earth are rammed well in round the wings.

Large stones and bricks should be well worked up to the sole-plate on both sides and for some distance, and should be well dressed with puddled clay; this in its turn being covered with gravel and fine shingle, as we have two difficulties to contend with. On the upper side we have the head of water, which, even if only a few inches in height, will assuredly, unless well checked as above advised, work its way under the sole-plate and well up on the other side, thus affording a free egress to the fry, which, always on the look-out for an outlet, will not be slow to take advantage of it.

Having the place in order, whether tank, box, or stream, the next thing is to catch the fry out of the troughs, and as they are by this time wonderfully active the glass tube is no longer of any use, and is accordingly superseded by a light hand net. The frame of this, made of wire, is of such a size as just to work easily inside the troughs, and is fixed into a short wooden handle; it is covered with muslin and

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used with the right hand, a bowl or other vessel being held in the left so as to be ready to receive the fry when caught. At first the unsuspecting little creatures will be very easily swept up, but gradually the last few become very cunning by experience, and dodge the net with wonderful speed and dexterity. It is sometimes a good plan to use a syphon of india-rubber tubing and draw off the water into one of the the lower tanks. Almost every one of the fry will make for the exit as the water sinks, and the few remaining may easily be got out by tilting the trough and sweeping them up in the net as the water flows back when the trough is again lowered.

Having caught the fry they must be taken in pails or other vessels to their new residence, and there set free, by gently turning the pail over when in the water. They will swim away and endeavour to hide themselves, making free use of the artificial shelters provided for them.

As an extra, especially where they only get two regular feeds, carrion may be hung up over the stream or box if at some distance from a house, and the gentles falling therefrom will be greatly relished by the fry, when of a size to enable them to swallow a whole gentle.

The above system should be pursued, suiting the quantity and size of the food to that of the fish, as long as they are kept in an artificial state. This period may extend as long as the trout-rearer pleases; but, as a rule, space is at a premium for future use, and the fry are turned out as yearlings to shift for themselves in the open river in March or April of the year after that in which they were hatched. If, however, there

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is abundance of room, especially where they are in an open stream, it may be advisable to keep them in for two years, as during the second year they put on flesh and growth to an extent which amply pays for the expense and trouble. Each person must, however, shape for himself the course to be pursued, as he alone can decide what will be the best to do under the circumstances.

If the general rules of procedure given above have been diligently followed, disease will scarcely be observed, as that generally has its origin from foul water, overcrowding, and want or excess of proper food.

When disease does break out, however, it is a terrible scourge, as it spreads with fearful rapidity, and sweeps off the stock wholesale.

The best thing, perhaps, for the trout-rearer to do, should any such calamity occur, is to turn the fry out altogether into the open stream and let them go their own way, as instinct will doubtless guide them aright if left to follow out their own inclinations.

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CHAPTER VII.

REARING PONDS AND STREAMS.

HAVING traced the practical treatment and management of the young fishes until the time when they require to be removed from the feeding box, we now turn to the question of the choice, modification, or adaptation, as the case may be, of any existing facilities for the further rearing of the fry, until they are able to reproduce their species or be turned into the open river to look out for themselves. Lucky indeed is the man who can see on his estate such a place as is well suited to his requirements, without much outlay. A good and unfailing supply of pure water, if possible well stocked with natural food, though this is not to be entirely depended on, and a sloping piece of ground, with a good firm bottom of chalk or gravel, will, with care and attention, and good management, enable a man, with his head set on the right way, to do practically all he wants. There are, however, a few points to be considered before proceeding to active operations.

Firstly, is the stream especially liable to either flood or drought; if the former, a side cutting controlled by a sluice or sluices is advisable. This cutting must have an exit below the contemplated ponds or stream, so as to guard against any overflow at the screens, which would admit of the escape of the fishes, always

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on the look-out for such an opportunity. This, too, will always be of service when it is desired to run off the water in order to catch or examine the occupants thereof, either for sale, spawning, or stock-taking. If drought be even heard of from the oldest inhabitant, when duly bribed with his favourite liquor, dams must be put up here and there, to retain a sufficient body of water in such a case.

Secondly, it will be necessary to find out whether, from any cause, the water of the main stream is likely to be "backed up" by neglect of weed-cutting on the part of those below, and out of the control of the owner. This will not happen if the fall be sufficient.

The nature of the soil, whether rock, gravel, or chalk, will merely vary the cost of the operations. Rock makes the soundest bed, but is generally more expensive to work, and grows less natural food, but the expenses of weed-cutting are correspondingly lighter; whilst gravel and chalk are easier to work, but not so permanent in their character.

There is one other matter to be looked into, or to which attention should be paid, namely, the proximity of a bed of good holding clay, or of a supply of hydraulic lime. One or other of these is necessary for the successful bedding of the various sluices, gates, and gratings for the easy and safe working of the project. What red and white lead are to the gas-fitter, one or other of these is to the pisciculturist.

Having made a careful survey of the site, if needful with the aid of a surveyor and his instruments, the owner may proceed to work. Having sketched out his plan to his satisfaction, marked the ground with pegs, and got out his "quantities" for excavation (if

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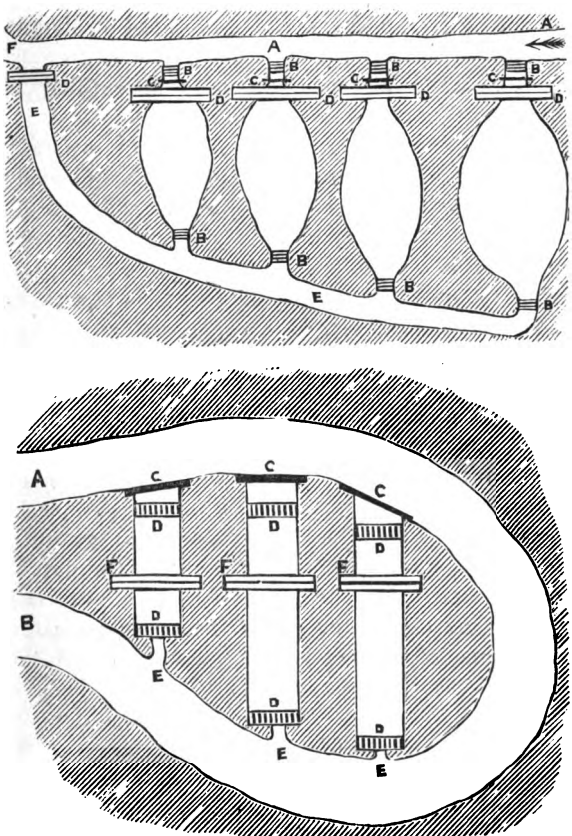
needed), we advise him to put out tenders for the work, "to be done to the satisfaction of himself and his architect or surveyor," generally the same person.



REARING PONDS.

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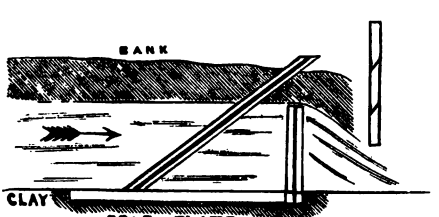
It being impossible, by any vaticinatory power, for the author to foresee all the circumstances of even the bare majority of cases in which such operations are to be worked, he must content himself with general remarks, adding a few sketches from fancy to act as guides to his readers.

Firstly, then, the deeper the water (in reason), the better and deeper will be the shape of the fishes; also they have more time to catch the food in its descent, of which they will not be slow to take advantage, the stronger feeding nearest the surface, and the weaker below them. This depth, however, must be controlled by the necessity of so regulating it that nearly all the water can be run off when desired by the side-cutting, for purposes named above.

All gratings should be sloping with the stream, exactly as in the feeding boxes above described, though the angle may be 45° or 50° from horizontal; this allows of a weak fish getting off them, if carried down by the current, especially if a "dead water board," on the same principle as a sluice, be placed below. The size of the zinc or iron wire used to act as a screen and prevent the exit of the fishes, must, of course, be determined by their size. So long as safe, the freer the current the better; but much must, in all cases, be left to the common sense of the owner.



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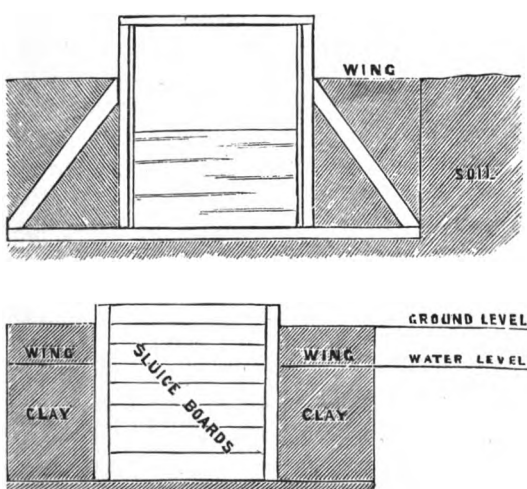
A wide sole-plate is advised because it affords a sort of dash board for the water, after it passes over the dead-water board, and prevents the washing away of the soil below the fall. Brick-bats, flints, or stones, should be placed so as to prevent, as far as possible, the wash of the fall, even if only of a few inches, as the ceaseless flow of water has a wonderfully erosive effect, more than the uninitiated would believe possible.

Sluices are to be set upright, and protected in exactly the same manner, except that they must be even more carefully guarded, as the fall is greater, as well as the back-pressure, or pressure of water from above; so that there are two dangers to be averted in their case.



REARING STREAM SLUICES.

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Clay is the great thing here; good strong holding clay is, as it were, the key-stone to the bridge of success. Neither fishes, nor rats, nor voles, the last two the greatest enemies the pisciculturist has to face, will burrow through it. Back up the clay with a lot of brick-bats, flints, or such rough stones as the nature of the soil and neighbourhood may afford—in a word, make a good sound lasting job of it. A sovereign or two spent at first may save £100 in fish before long.

As to size, that depends on the volume of water, number of fishes to be reared, and various other matters, nearly all of which must be left to the judgment of the operator. Small ponds are, as a rule, better than big ones; they are more easily cleaned, netted, and protected than large ones; if a bit of a water-logged tree can be found, stud it with tenter-hooks, and sink it with a rope attached to the bank *under water*, and the poachers, if they come, will find more than they bargain for. Wire-netting may be stretched around the ponds to keep off herons; these pests like to steal quietly down a slope into the stream or pond, and cannot abide wire-work; they give a squall and fly away. Alarm-guns, as made by Mr. Burgess, of Malvern Wells, are also good; they, if set at the right height, scare both herons and men, and tell the keeper that someone is about.

In turning the well-grown fry out of the feeding-boxes the hand-net is used. It should be about the size of the feeding-box in width, with a good bag of cap-netting. Time has to be saved and the work done as expeditiously as possible. When the last few have to be caught shut off the water supply, and syphon off all the water into a pail with a tight-fitting

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rim of perforated zinc round it. The water flows through and the fry are thus retained; they can be turned out into some other vessel and conveyed to the pond. Never mind any mess, that can be easily cleared up afterwards. When the syphon has done its work, tilt the nearly empty trough, and the rest of the fry are easily got out by the net, especially if a wave be made by the net, and then placed so that the returning water shall pass over it.

Shelters or shades are very good in ponds, but they must be portable; nothing should be fixed. The owner should be able to look over the entire surface of the "farm under water;" besides they can be taken out when desired, and roll up a poacher's net beautifully. If there be plenty of hides, ten thousand fry will "put themselves away" in a twinkling, and only come out when hungry. It is a wonderful thing to see under what small shelters young fishes will manage to conceal themselves.

When settled in the ponds, well-boiled bullock's lights, cut fine in the Starrett meat-chopper, should be given, also the fish-biscuits of Spratt's patent (Henry Street, Tooley Street, Bermondsey), soaked just enough to be friable; they may be crushed in a mortar and then soaked. This is nice variety for the fishes, both young and old. Three feeds a day will now suffice, or even two, if there be any natural food in the water, as there generally is in a pond, especially if fed by a spring exposed for some distance to air and sun. Insects light on, or rise to, the surface, and are snapped up (or rather down) as unconsidered trifles, thus affording food and amusement to the inhabitants of the pond.

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A "maggot factory" may be established at the head of the pond or ponds, so that the maggots keep dropping in, so soon as the size of the fishes enables them to swallow one. A box with double sides to keep an even temperature, a closely-fitting lid to keep in the stench, and an open wire-work bottom to admit flies and for the exit of maggots is a good idea; it was shown at the London Exhibition of 1883. It is supported on posts, or suspended from a sort of gibbet over the water; any vermin trapped or shot may be suspended in it, either on small meat hooks or otherwise.

Mr. Francis, in his "Practical Management of Fisheries," an excellent work, recommends that *boys* be employed to collect worms, snails, &c., for the young and old trout. Our experience of boys is that each boy wants two men to look after him, and that his services are rather dear at a gift; however, there may be boys and boys. "Boys will be boys" is an old saying; and we can only caution the reader to avoid what we have always found the quintessence of slyness and mischief. Perhaps far from the larger towns they may be more unsophisticated, or the exception may prove the rule, but we do feel strongly on this point.

For merely feeding, preparing food, and such light work, we should certainly prefer female labour, as being less costly and in many ways more trustworthy.

Anyhow, we must agree with Mr. Francis in his recommendation of a varied dietary; the greater the variety, the greater the rate of growth. For the older trout, any odds and ends from a butcher's shop will prove acceptable, especially if they can be bought at a

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very reasonable cost on a Saturday night, and sunk in a sort of cage of perforated zinc in the head of a cold spring; there, though not so tempting to the eye of the pisciculturist, they will keep for days, yet more especially if dipped for a few minutes in really boiling water. This "sets" the outside albumen, and, as it were, seals the meat, keeping in all its juices and nourishing power.

Or meat may be dipped in sulphurous acid or a solution of salicylic acid, and hung up in a game larder with a good current of air through it, flies being kept out by panels of perforated zinc. All these little matters may seem too trivial and unimportant to require mention here, but when many mouths have to be fed the great secret is to find out and carry into practice those methods or "dodges" which lead to the best results with the *minimum* of trouble and expense.

Everything must be done methodically and with the regularity of clockwork; for fishes, like fowls, know the feeding time just as well as those who feed them; and when they become accustomed to one person as feeder, will follow him like a pack of hounds at their meal-time. They will become so used to him that after a time they will take food readily from his hand, and if immersed without the usual contents that hand may receive cordial recognition in the shape of sundry sharp nips from the mandibles of the disappointed fishes.

It is strange, too, to see how fearful fishes are of strangers. If friends come to see the food given, except there are frequent visitors, so that the denizens of the water are accustomed to such scenes, they fight

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very shy even of their regular attendant, unless almost mad with hunger, a state in which they should never be found in a well-regulated artificial preserve. On the withdrawal of the unwelcome intruders, a vast splashing takes place and the food soon vanishes. This is more particularly the case when and where the surface is unruffled by the breeze or the natural force of the current; just, in fact, at the most favourable spot for the fishes both to see and be seen.

To clear the exit from a pond a wooden guard may be placed at the opening, a foot or two away from the outlet screen, say eight inches under water, and four above it; this keeps the thick of the falling leaves off in autumn, as they can be raked off with an ordinary hay-rake and carried off in a wheelbarrow to a place of safety. All the little plank foot-bridges should be so made that a wheelbarrow can run easily over them, the planks being so close together that the wheel cannot slip through. A wheelbarrow is quite indispensable about fish-ponds. If cans of fish have to be taken up or down; clay, stones, or gravel moved; or anything else is in hand, the barrow comes in handy, and it is better to have two than none.

In our variable climate, with its sudden drenching showers, a shanty of some sort close to the ponds is a great boon, especially if the ponds are any distance from home. Fish can be carried there for stripping; and if night watching is required at any time it will be very convenient.

One great thing to bear in mind is to plan everything as compactly as possible at the first; it makes less work, and work will often be done thus which

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never would be done at all under other circumstances. If things are worked, as far as possible, automatically, and a good method established in doing them, then trouble is minimized to the last degree, and all go about their day's work in a cheerful ready manner. If any accident should happen—and in spite of all prevision such things will occur—then the hands will be better able to meet whatever may suddenly supervene.

A short step-ladder, such as is used for a bathing place, will be found useful for entering and leaving ponds without injuring the banks, should they be perpendicular.

For cleaning the numerous screens and gratings, more especially of a tender nature, such as perforated zinc, Horsey's patent bass brooms will be found the best; they can be got through any ironmonger, or dealer in turnery goods, and will be found useful not only at the ponds, but for sweeping out the fish-house. A mop and an india-rubber "squeeze" are about all else that is wanted in this department, except an ordinary scrubbing brush.

In places where mussels and clams are to be had *cheaply*, and girls can be hired to open them, they form a good change of food, but these places are rare. Horseflesh, if easily procurable, is also a desirable item of *menu* for the older fishes; or, on a "juicy" summer's night one may take a lantern and tread softly on the lawn, and, with a bag slung on the shoulder, pull out lob-worms, and feed them to the fishes. In fact, hardly anything will give offence in the way of food. To make good growth there must be lots of food, and that varied as much as possible.

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Many old houses, especially in their lower regions are infested by cockroaches or blackbeetles. They are voted a pest, a scourge, and an awful nuisance by all; but the trout, when old enough to eat them, think otherwise; so a raid in the kitchen and sculleries may prove beneficial alike to the inhabitants of both house and ponds. We believe the following is the *modus operandi;* unfortunately we are unable to speak from experience, as the *genius loci* has used phosphorous paste for many years, so that these charming creatures are as rare as odoriferous at home.

When all is quiet, and the faintest creak on the stairs creates an echo, walk as softly as if picking lobs from a lawn, in list slippers, or other noiseless foot-coverings, and with a gauze net, such as is used for clearing the feeding boxes, guided by the feeble blaze of a night-light, steal into the kitchen or other rooms infested and sweep the floor very carefully, exactly as if catching fry. When the net is full it may be emptied into a regular beetle-trap, or large spittoon; anything, in fact, which will incarcerate the beetles till wanted.

The writer has been told that, in many old country mansions, quarts may thus be obtained in a single evening, the great thing being to go in quietly, shade the light as much as possible, sit on the kitchen table motionless until the confidence of the prey has been perfectly restored, and then, and not till then, set to work in a business-like manner. The authorities below stairs may have to be compensated to some extent, as in the "hurry of business" several squashings of belated beetles may take place; but that is a very easy matter, if the quarry be so numerous that the game is really worth the candle.

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CHAPTER VIII.

DOES ARTIFICIAL SPAWNING INJURE A STREAM?

TO this question we simply return the answer "No." Look how fishes follow each other on the same "redds" or spawning grounds; how they destroy each others' nests; how they eat each others' eggs. "Is it peace" always at the spawning season? Have we not seen trout gashed about fearfully by their fellows? The males fight fiercely, and whilst these lethal conflicts are going on, the female, unable longer to retain her ova, will, likely enough, shed them without the assistance of the male; they are then, of course, wasted.

Competent authorities have stated that not more than five per cent. are ever impregnated in a natural state of things. Is it not, then, better to take at any rate a goodly part of the eggs of a stream, artificially impregnate and hatch them, sell what can be sold, and return some of the fry to the stream whence they came? Still better, perhaps, would it be to introduce young fry from other waters, as a change of strain, if judiciously managed, may do wonders for a stream. Fresh blood is often a great benefit in nearly everything, from a Ministry to a pig-stye, and assuredly a trout stream is no exception; but one great point should never be lost sight of; that is, every egg should burst in the water the fish will afterwards inhabit.

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Then there is no bother about acclimatization, no risks from change of temperature, hardness of water, or the hundred and one other sources of danger to young fish life that do so constantly beset it under circumstances of sudden change. Fry come from a distance, perhaps at nightfall, and are turned in, possibly by a gardener or keeper, who is in a hurry for a meal, and he never thinks of such a thing as a thermometer, even if he could see to read it, whereas a *sudden* rise or fall of a few degrees of that instrument may hash the whole lot.

Our own opinion is that artificial spawning does an unmixed good; it saves fighting, saves eggs, is an interesting amusement, as well as a source of possible profit; at least it has proved so wherever it has been fairly tried, and an unbiassed judgment has been formed as to its results.

There are people, of course, who declare that such proceedings ruin a stream; but then there are people who will cheerfully swear that black is white, or that all the evils of a country proceed from the doings of this or that political party (usually not that which they espouse); but such may be left to grovel in their ignorance. If you talk to them about a man being a benefactor to his country who makes two blades of grass grow where there was only one before, they will probably agree with you; but get to fishes and they appear unable to recognize that any great blessing can possibly emanate from hatching ninty-seven per cent. instead of only two or three. What, they will ask, is the use of turning into a stream such little mites of things? We answer by asking — If hatched out naturally, would they be any bigger? They are kept

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from all natural enemies until able to swim freely, hide themselves, feed, and generally look after their own affairs. Turn in one thousand fry, and see how soon they will get out of sight; that is, provided there shall be weeds or other hiding places to get under.

Young fishes are, we may feel sure, animated by a natural instinct for self-preservation, and a keen look out for the main chance of existence, just as much, if not more, than we are. Look how at a certain age, soon after birth, they bore down stream. We find them "bunched" where the water runs out, and if they possibly can find a hole for escape, out they go, one after other, as fast as they are able. Why is this? Natural instinct tells them, just as reason tells us, that the water may fall, and leave the "redds" or spawning grounds high and dry; so away they go to safer quarters.

After this discursive chapter, all we have to say is, that as a whole, and from personal experience, we are more and more convinced that taking eggs artificially to a certain and considerable extent from a stream, more especially if a percentage is returned in the shape of fry, is AN UNMIXED GOOD.

More especially is this the case on streams wherein pollutions, however slight, either do or may exist. The older fishes, being partially it may be, acclimatized, will be, perhaps, able to stand, through robustness of constitution and sheer strength, a certain amount of pollution; but to the young, immature, weakly troutlet, such a thing is fatal. They cannot jump weirs or obstructions in order to get above the source of filth. Nor have they the swiftness and "nous" to fly before it and turn up a side-stream out of harm's

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way till the trouble has passed. Thus they die, and are lost to the breeder and the fly-fisher, unless the artificial method of protection in pure streams and ponds be employed.

Were it not for this fouling of the water, many a fair stream we wot of would have its shallows black with healthy thriving trout; instead of which we find them black with refuse from "works."

When we settled down to write this chapter, we made up our mind to put the case fairly and straightforwardly before the reader, feeling sure that a dispassionate consideration of it will entirely win him over to our view of the matter, whatever may have been his previous opinion.

The question of pollution of rivers is a large one, and will be more or less exhaustively treated under the head of "Enemies."

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CHAPTER IX.

ENEMIES.

THE hostile forces ranged against the eggs and young of the salmonidæ may be said to be "legion," so many are they. From the moment of extrusion from the maternal ovaries, the eggs are the prey of other fishes, shrimps, beetles, birds, rats, voles —even cats. In a word, everything that has a mouth will be found partial to them. Shrimps are terribly destructive, as they burrow through the shingle forming the "redd" or nest, and do their deadly work unseen. We have put shrimps and trout eggs together in a vessel, and watched them minutely. They go from egg to egg, biting a small piece out of each, just enough to kill it. If they were to devour one egg each per day, wholly confining themselves to it, that would be bad enough; but they seem animated by a spirit of wholesale destruction. What reason there may be for this is unknown, unless it be from an instinct implanted in them for the purpose of keeping down the numbers of the salmonidæ.

Beetles and birds greedily devour the newly-hatched fishes, as do rats and voles; when older, the king-fishers swoop down on them, flashing up and down the stream—a wonderfully beauteous sight for all but those who make pisciculture either a business or a pleasure.

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When older still, more especially at spawning time, the ungainly heron stalks around and spears all he can on the shallows, very often destroying fishes too large to be swallowed; so it is a fact that the fish has enemies constantly on its trail from birth to death.

Shrimps, dabchicks, and other enemies of the fish-egg, are checkmated by the artificial process of breeding. Rats and voles can be trapped in gins carefully laid under the surface of the water at the mouths of their holes, or shot by the keepers; and for such a purpose the little walking-stick guns, sold by many gunmakers, are very serviceable weapons, as they shoot very hard with a very small charge, and make so little noise as not to disturb the game in a covert.

Kingfishers, though it seems a sin to kill so lovely a bird, must be kept down, or they will clear a stream more quickly and effectively than would appear credible. We were pestered with them, found our stock going fast and could not make out the reason. Taking the advice of a friend, we ordered some traps, from Mr. Henry Lane, of Eagle Works, Wednesfield, set them on slight poles painted white, in the middle of our little breading stream, and in a short time scored our thirty-sixth kingfisher!

The same maker supplies the extra-sized round hawk traps, which are securely pegged down in the shallows at spawning time. Into these the heron steps, and an end is thus put to his marauding.

Pike, too, must be well looked for, shot, netted, snared or otherwise destroyed, and that before they spawn, at which time they approach shallow, weedy places, and an expert wirer will have little difficulty in noosing them round the body with his wire and light pole.

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Perhaps, however, the most fearful of all enemies of fisheries is the polluting manufacturer. A tank of bleach from a paper mill, or acid refuse will do more to destroy the fishing within a certain range than all the other foes put together, as it not only destroys the fishes but also the food on which they subsist. The tough seasoned fish may stand it for a time, but to the immature or weakly fish these visitations are disastrous indeed, as has already been pointed out in the last chapter.

Fortunately, an Act of Parliament of comparatively recent date has been found to be of much greater utility than was expected. Under the Rivers Pollution Bill several signal convictions have been secured, and it is to be hoped that the scope and general usefulness of the measure may be increased, as the benefits it confers are more widely known and appreciated. Most of us will have heard of the fearful outcry against the Alkali and Smoke Acts, some years ago; now that the benefits they secure are fairly appreciated, the manufacturers, against whom these Acts were primarily directed, are asking for a more stringent enforcement of a yet more stringent Act.

The fact is, that when once a man finds he can in the "long run" *make money* out of what he formerly threw away, he generally is not slow to adopt any new process having that end in view, to his own advantage, as well as that of his neighbours.

Changes of practice, as well as of thought and habit, are naturally slow in their advent; but we trust that in a few years great strides may be made in the extinction of the frightful pollutions that now foul our

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streams, disgrace our (so called) civilization, and destroy the harmless recreation of our toiling population, to say nothing as to their bearing on the public health, both of men and animals, and the utilization of "waste" substances, which, were the system only sufficiently known, thought of and carried out, would, by mutual exchange of "wastes," doubtless enable our manufacturers to lessen the cost of production; and thus they would be in a better position to compete with other producers, both in this country and abroad, where wages are so much less.

Although not actually connected with the heading of this chapter, and perhaps pertaining more to the domain of Political Economy, we make no apology for saying that the foreign mechanic, by frugal living and, as far as possible, the *utilization of all waste*, can keep a good table, good clothes on his back, and a comfortable home together, where our working population would simply starve.

Why is this? We reply—because the wives and mothers abroad are born cooks, taught the methods of turning out a savoury meal from almost nothing (so far as cost goes) from an early age, and are imbued both by precept and example with the value of thrift.

However much we may disapprove of over education in schools for the working classes, thank God the schoolmaster is abroad; and we do hope that one of the things taught will be cookery, practically as well as theoretically; and more especially the cooking of fish. Certain sorts of fish are very cheap, and, if properly sent up, are very nutritious and palatable.

After this digression, before we close this chapter, it gives us unfeigned pleasure to refer to the efforts

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now being made by the Mill-owners and Manufacturers Association to abate the evils of pollution. They give advice, counsel, instruction as to the best methods of carrying on any factory or business innocuously, devise, construct, and, if need be, erect the best possible or known apparatus for so doing, and deserve support from all quarters. At the late Fisheries and Health Exhibitions they received richly-deserved honours, and we trust that they may go from strength to strength, and add good work to good work done, until their influence is paramount in the land, and the manufacturer shall have such confidence in this most worthy Association that he will turn to it in any case of doubt, of difficulty, or uncertainty of procedure, in the same manner as the navigator looks for aid to his chronometer, charts and compass.

It is therefore with great pleasure that we insert the following particulars of the Association :—

"The Rivers Pollution Prevention Act 1876" enacts, "That any person who causes, or knowingly permits, any noxious or polluting liquid proceeding from any factory or manufacturing process to fall or flow or to be carried into any stream, shall be deemed to have committed an offence against that Act;" and recent legal decisions clearly indicate the intention promptly to enforce the strict observance of its provisions. It has hence become an imperative necessity with many persons to consider how, under these conditions, it will be possible for them to continue to carry on their business.

In the great majority of instances, neither the owner nor the occupier knows the proper means for, or the cost of, preventing or "rendering harmless"

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any noxious or liquid matter proceeding from his works; and he is unwilling to encounter an expense which may prove more than he was prepared to incur, and possibly, in the end, not sufficient to protect him from the penal provisions of the Act.

Capital, skill, and experience are therefore essential requisites, and the Association is now prepared to supply them. It will either perform the work, or advance money for its performance. The payment in either case may, if desired, be postponed until after the completion of the works, and be, as agreed, in one fixed sum, or by instalments extending over a period of years; and, moreover, the Special Act of the Association provides, that on the certificate of an Inspector appointed under the provisions of the Rivers Pollution Prevention Act, that proper means have been used, and on an order of the Inclosure Commissioners for England and Wales obtained for the purpose, the entire outlay and all attendant expenses may be made a charge on the property, in much the same manner as landowners are enabled to charge their estates with the cost of drainage, buildings, &c., under the several Land Improvement Acts.

The Inspector's certificate will also afford protection against any proceedings under the Rivers Pollution Prevention Act.

No investigation of the owner's title will be necessary, as the Special Act also provides that the order itself shall be "conclusive evidence in all courts of the validity of the charge."

Owners, Lessees, or Occupiers who may labour under any difficulty as to the discharge of the overflow from their works, are consequently *invited* to place

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themselves, either by personal application or by letter, in communication with the Secretary, who will thereupon furnish instructions for the commencement and (if found desirable to both parties) conclusion of a contract for the removal of a difficulty.

This Association is incorporated expressely to *assist* Manufacturers, Mill-owners, and others to comply with the provisions of "The Rivers Pollution Prevention Act 1876."

1. The Association offers to send, for a small fee to cover expenses to be previously agreed upon, a qualified surveyor to ascertain whether any "liquid" discharge from any industry causes an offence against the Act. If the Surveyor reports—

(a.) That there is no such offence, the report may be a preventive against litigation, and evidence in case of litigation;

(b.) That there is an offence, but to his knowledge no known practical remedy, the Association will pay one moiety of the fee;

(c.) That there is an offence, and a known practical remedy, which will be specified by name or by some general description, the Association offers to proceed as follows:—

2. On the receipt of the report *(c)* the Association will, if requested, and for a moderate charge to cover the expenses to be previously agreed upon, direct the Surveyor to make *working* plans and specifications of the works, etc., for the application of the remedy, and state the sum which in his judgment will cover the cost of all works and charges.

3. The Association will then, if desired, either carry out itself the works specified by the Surveyor

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for a sum to be agreed upon; or else *advance* the requisite funds for that purpose to the Manufacturer or Mill-owner on terms to be arranged.

4. The payment or repayment of any such sum or advance may, if desired by the Manufacturer or Mill-owner, be made a statutory charge on the premises *under the special powers of the Act of Incorporation*, and be repayable with interest at the rate of five per cent. per annum by equal half-yearly instalments within a period not exceeding twenty years.

NOTE.—Every worker of an industry will understand that he may avail himself of the powers of the Association for the advance, payment, and statutory charge of the cost of the *requisite purification*, although the purification may be effected by a process and works recommended by and carried out under his own surveyor.

Any further information may be obtained from the Secretary, at the Offices of the Association.

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CHAPTER X.

STREAM CLEANING.

IT very often so happens that a stream possesses every element of suitability for fish-culture, but it is so choked and blocked by mud, weeds, and rubbish of one sort or other that its capabilities are concealed from view, and it might easily be overlooked when seeking a suitable place for fish-culture, more especially in the earlier stages of growth. There is only one thing for such a place—namely, labour. Strong arms and backs; good scoops, rakes, and Horsey's brooms, with good sound, tight waders, will do a lot in a few days.

Whilst the mess is about, things should be done very thoroughly, only leaving enough of weed to form slight shelters for the young fry when first turned in; but a little patch of "sandy mud," if we are permitted to use such an expression, if left here and there, will afford much food to young fry—food of a natural sort, perhaps better than any artificially introduced. There is, or may be, such a thing as being too clean in fish-culture.

The last brush over may be downwards, the sweeper standing below his broom, and thus extinguishing all footmarks, and leaving a clear level bottom. When once reduced to good order a little supervision will easily keep things right. A moderate growth of aquatic plants may safely be encouraged, as they furnish much natural shade and food, as well as a store of oxygen to the water.

Where the stream is narrow and moderately swift the mud may be helped on its downward course by

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nailing a wooden handle on to a board and putting it on the bottom, then lifting it and placing it a few inches further down the stream ; the board backs up the water and creates a scour when lifted, which clears off mud with great rapidity.

In many streams diatoms, a sort of alga, of an olive hue, growing by "self fission," are a great curse to the fish breeder, as they cover everything with a disgusting film, clog screens, and necessitate constant care and attention, or some very awkward consequences may follow, such as choking of screens or loss of fishes. By the use of clay, however, this is easily obviated, as the clay, acting like a soap, breaks up the masses of alga and enables them to float down stream, and pass the screens without clogging ; nor does it appear in any way to injure the young fishes. Clay, therefore, is one of the best of friends to a trout breeder in such a water.

By the use of sluices and a side-cut for waste as described above, much may be done in one pond or stream without in any way disturbing or fouling those below ; the current is easily under control, and everything may be done decently and in order, to the satisfaction and benefit alike of the fish breeder and his charges ; the great thing being to look ahead and meet evils half-way. If a thing has to be done it should be done thoroughly and at once, but with discretion and judgment, after due and mature consideration.

Had the Cray been only what nature made it, a clear, bright rippling trout-stream, ere this it would have been one of those ideal Edens for the fly-fisher of which we often read, but which it is seldom our good fortune to see.

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CHAPTER XI.

ACCLIMATIZATION.

SO much has already been written on this and kindred subjects, and by so far abler hands than ours, that we would fain leave the subject alone, were it not that we feel it incumbent on us to speak boldly on one or two points.

Firstly, let us deal with the question of improving our stocks of salmonidæ by the crossing of native strains. In favour of such a practice too much cannot be said. If there were a sort of central fish-egg exchange, so that owners of water could send up some of their eyed ova, and receive in lieu thereof ova from different waters, great advantages would accrue to all; and as there already exists a National Fish Culture Association it may easily be conceived that such a matter as this would naturally come within the scope of its operations. The size and general quality of our native Salmonidæ could not possibly suffer by such an institution, and such results would be attained as would fairly astonish those who have not seen similar experiments carried to a happy conclusion in other animals.

Whence have we our prize Shorthorns, Devons, Herefords, and other fine breeds of cattle. Simply by mixing or crossing various strains: but mixing *with brains*—not haphazard work, but work that demands all the knowledge, thought and experience that the

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breeder may possess. In the former case there is a stickfast tendency, if not a deterioration, for an injudicious mating is certain to yield bad results; in the second, improvement is a certainty, sooner or later. All such improvements, however, require great care, skill, patience, and time.

Our great breeds of domesticated animals, of which this country may justly feel proud, seeing that they are eagerly sought by foreign buyers whenever offered for sale—were not built up in a generation; nor will our fisheries revive, unless all, great and small, "put their shoulders to the wheel," and get them out of the deep rut into which, by mislegislation, or one-sided action, they have unfortunately fallen. Mismanagement tells its own tale on sea, lake, and river.

Now we come to the question of importing foreign and, for the most part, predacious fishes. This topic is a sort of craze or mania with some people. The Black Bass, the Wels (Silurus Glanus), and others of the same feeding habits, have their advocates; men who espouse the cause of their *protegés* through thick and thin, who pay little attention, as is the wont of partisans, to anything said on the other side of such a question.

What do we want with these voracious fishes? Have we not our *Esox Lucius*, pike of our waters, masealonge of our American cousins? Is he not depredator enough for all practical purposes, aided by the Perch (Perca Fluviatilis)? Will any sane man tell us that it would be safe to largely import the Wels, growing as it does to an enormous size? Is it consistent with reason that a fish, purely carnivorous, can attain a weight, as well as *maintain* it, of over one

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cwt., without committing fearful havoc? Besides, it is not, so far as we can find out, a "game" fish, in any sense of the word, like the Black Bass (Grystes Nigricaus). This last named fish, about the most voracious and hideous of the fresh water fishes of the world, does give grand sport; but if once it were to find its way into our trout-streams, there can be no doubt as to the result, so far as the trout and grayling are concerned.

Fishes will, by hook or by crook, find their way around, and it therefore behoves us to be very careful how we introduce anything without duly considering the matter in all its bearings, thinking over and studying the formation and habits of the "little stranger" for ourselves, before we listen to our enthusiastic friends.

As another example of the care needful in such matters, we may instance the American Brook Trout, really a Charr (Salvelinus Fontinalis). This beautiful and game fish has been introduced, at great cost, into many English waters; but where are they now? Except in very rare instances, which might be reckoned on the fingers of one hand, they have all disappeared; either they do not suit the water, or the water does not suit them. Anyhow, in conclusion, let us rather seek to improve our native breeds, draining our own resources to the dregs rather than, desiring novelty, go after strange gods in the way of fishes from foreign countries.

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CHAPTER XII.

CONCLUSION.

THIS little work has been written with the express object of so guiding the owner of water in the management of his fishery, that by following out the broad principles laid down disease may be averted and success ensured. If personal acquaintance with all the practical details of breeding and rearing trout can give an authority to speak on such subjects, the writer may well claim that authority, as he has for some years carried on, with his own hands and under his own charge, a small fishery, the success of which has fairly astonished him. When first setting out, he was so much hampered by doubts and fears, and perplexed about many things, that he hardly knew what course to pursue; and right glad would he have been to have had at hand such a book as this to refer to. However, in any work on a subject which is as yet in its infancy, many errors will necessarily occur, and the writer hopes that those herein will be found and corrected in a future edition, should that be called for.

Some may very probably grumble at the smallness of this book, and consider it superficial, or think that the subject has not been sufficiently elucidated. The answer to all such objections is that, when really understood, trout culture is intrinsically by no means a difficult matter, requiring years of study; that its

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processes are all simple, requiring patience and practice rather than genius in comprehension. And lastly, that to crowd a practical work with unnecessary matter, in other words to pad it out, is worse than useless, as the fewer words that are used the more easily are they retained in the memory.

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ADDENDA.

Just as when letting out an old friend at the lodge gate one or other last thought crops up, so it is in finishing a book, whether large or small, the brain feels overcome by a sense of fear lest something or other may have slipped the memory. Therefore, in as few words as possible, a few matters are touched on here, the more firmly to impress them on the reader's mind.

Get a trustworthy, thoughtful assistant, one who will faithfully carry out what he has to do, whether under the eye of his employer or not. Such characters are rare, and have to be sought for; when found, every possible inducement should be given to cause them to stay. Such a man is generally a "character" in one sense of the word, and any harmless idiosyncrasy should be carefully humoured—nay, fostered; for a man of originality of thought will generally prove ready at expedients when most wanted, and in a fishery, of all other places, *contretemps* are most likely to occur without notice.

Get everything ready before it is wanted and season it well before use, so as to avoid doing anything in a hurry.

Use only ripe eggs and milt and carry out the "dry" method as directed; you are then sure of success.

Never give sour or *tainted* food; a little starvation is the lesser evil of the two.

Look carefully at all screens, gratings, and other sources of loss, and keep a good heap of sound clay

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ready to hand, even if only for temporary use. Always have spare screens ready fitted; they can be dropped in after nightfall if needful.

Listen carefully to the sounds of the various running waters, especially at the outlets; anything wrong may thus often be detected by the ear alone, and the site of the evil allocated with some degree of exactness, more especially as things generally go wrong after dark.

Use plain taps in all fittings; spring taps where there is a very high and constant pressure, direct from a Company's main; the old slotted taps are far preferable for all ordinary work, especially in unfiltered water.

Never alter a tap after two or three p m., so that the regular run of water may be seen by *daylight*. In such little matters the eye is very easily deceived by shadows cast by artificial lights.

If anything does go wrong, keep as cool a head as possible, act promptly, and try to seek out the cause of mishap, and so arrange that the trouble may never recur, if possible.

All means of turning water on to or from a fishery should be under lock and key, and that key should be under another lock, only accessible to the owner and the manager.

Finally, keep on as good terms as possible with those around; bitterness of feeling may prompt many an act of wanton or secret mischief; whereas a friendly feeling may ward off, or forewarn of coming troubles, and give useful information, leading to both pleasure and profit.

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